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APS BEAMLINE STANDARD COMPONENTS HANDBOOK

Version 1.3

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INTRODUCTION

It is expected that the members of the APS Collaborative Access Team (CAT) would like to concentrate their effort on designing specialized equipment related to their scientific programs rather than on routine or standard beamline components. Thus, an effort is made at the APS to identify standard and modular components of APS beamlines. Identifying standard components is a non-trival task because these components should support diverse beamline objectives. To assist with this effort, the APS has obtained advice and help from a Beamline Standardization and Modularization Committee consisting of the following experts in beamline design, construction, and operation:

Richard Boyce	SSRL
Richard Hewitt	EXXON and CMCCAT
Tunch M. Kuzay (Chair)	APS
Richard Levesque	LLNL
Ed Melczer	LBL/APS
Dennis M. Mills	APS and SRI CAT
Tom Oversluizen	NSLS
Wilfried Schildkamp	University of Chicago and CARS CAT

A group of CAT representatives have also joined in this effort to lend their views on the subject.

Based on the charge given to this committee by Gopal Shenoy, Director of the Experimental Facilities of the Adavnced Photon Source on January 22, 1990 (see Apppendix A), the committee identified the following tasks:

1) to identify standard and modular components of an APS insertion device beamline,

2) to insure safety and quality in the beamline design concepts,

3) to develop conceptual and engineering designs for the components,

4) to review the designs,

5) to develop prototypes,

6) to disseminate the information to the user community and vendors.

(Tasks 2, 5 and 6 are carried out exclusively by the staff of the APS.)

In addition, the guidelines to this committee called for the following considerations:

- modular design of as many components as possible,
- vendor production design to reduce cost to users,
- safety of personnel and equipment,

- ALARA* design objective,
- Experiment Hall should be a Class IV restricted area (500 mR per year)
- engineered safety included in all the components to avoid inadvertent actions leading to hazards
- interlocks with adequate redundancies as well as visual and audible alarms to prevent human errors,
- spares for standard components will be available in the APS stockroom.

With these guidelines in mind, the staff of the Experimental Facilities Division identified various components thought to be standard items for beamlines, regardless of the specific scientific objective of a particular beamline. A generic beamline layout (see next page) formed the basis for this identification. This layout is based on a double-crystal (or multi-layer) monochromator as the first optical element, with the possibility of other elements to follow. Preliminary engineering designs were then made of the identified standard components. The Beamline Standardization and Modularization Committee has reviewed these designs and provided very useful input regarding the specifications of these components during many meetings.

This *Handbook* in its current version (1.3) contains descriptions, specifications, and preliminary engineering design drawings for many of the standard components. The design status and schedules have been provided wherever possible. In the near future, the APS plans to update engineering drawings of identified standard beamline components and complete the *Handbook*. The completed version of this *Handbook* will become available to both the CATs and potential vendors. Use of standard components should result in major cost reductions for CATs in the areas of beamline design and construction.

Because of the involved nature of the job at hand, we encourage CAT Directors to inform us of their specific needs as they progress in completing their beamline preliminary designs. The engineering drawings, in their current state of design, for the identified standard components are now available on the APS Design Exchange.

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*ALARA ("as low as reasonable achievable") refers to DOE's policy of establishing a program for minimizing radiation exposure to personnel and equipment.

1. Vacuum specifications

1.1 APS beam transport - windowless

1.1.1 APS beam transport - mirrors

1.2 APS beam transport - Be window

1. Vacuum Specifications

The Storage Ring defines the vacuum conditions in the front end, which is the link to the beamlines. A pressure of $1x10^{-9}$ torr or better will be maintained in the Storage Ring during operation.

The pressure in the beamlines will strongly depend on the components that will be used to transport the beam to the experiment. The interface between beamline and front end is the front end valve (FEV) in the first optics enclosure (FOE). The pressure in the beamline immediately upstream of this valve must be $<1x10^{-8}$ torr in order to obtain permission to open the valve. The pressure at the safety shutters (SS2) in the front end must be $<6x10^{-9}$ torr. Figure 1 illustrates the situation. The trigger gauge downstream from the front end valve will have two set points. When the pressure exceeds $1x10^{-8}$ torr, the slow valve (SV) will close. If there is an accidental venting and if the pressure rises in less than 1 ms to more than $1x10^{-5}$ torr, the fast acting valve (FV) will be activated followed by the slow valve. Figure 1 also shows the setup for windowless operation with two differential pumps (DP), which allow a higher pressure limit for the beamline operation to be $<1x10^{-6}$ torr (instead of being $<1x10^{-8}$ torr in the absence of the differential pumps).

1.1 APS Beam Transport - Windowless

Beamlines under vacuum have to maintain a pressure $<1x10^{-6}$ torr. To have a windowless connection between the beamline and the front end, a differential pump will be needed. This achieves the needed pressure at the front end valve ($<1x10^{-8}$ torr) and an additional delay in shock wave propagation (in case of accidental venting) to protect the front end. For pumping, ion pumps are recommended. The vacuum of the beamline must be free of hydrocarbons. This will be verified (by the APS) upstream from the front end valve through residual gas analysis. The result of this analysis must be that the masses above 38 have a total pressure of less than $5x10^{-11}$ torr.

1.1.1 APS Beam Transport - Mirrors

All beam transports that are connected without windows to mirror chambers must be particularly free from hydrocarbons to avoid carbon contamination of the mirrors. It should be verified by the CAT that hydrocarbons contribute less than $1x10^{-3}$ to the total pressure of these beam transport components. This can be verified by the mass spectrum of a single component. The sum of the masses >38 has to be less than $1x10^{-3}$ of the total pressure.

1.2 APS Beam Transport - Be Window

Beam transport that is separated from the front end by a Be window has to be evacuated to a pressure $<1x10^{-6}$ torr. To avoid carbon contamination of the window, oil free pumping of beamline components is required.

If the window terminates the vacuum part of the beamline, special measures must be taken to prevent contamination from the atmospheric side. Exposing the windows to air with the beam on will not be allowed. If the beamline design does not permit vacuum on one side of the window, we suggest one of the following measure be included: a short clean hydrocarbon-free He buffer (terminated by an Al foil) or a protective coating on the window. The mechanical and thermal design of the windows is discussed in section 4.

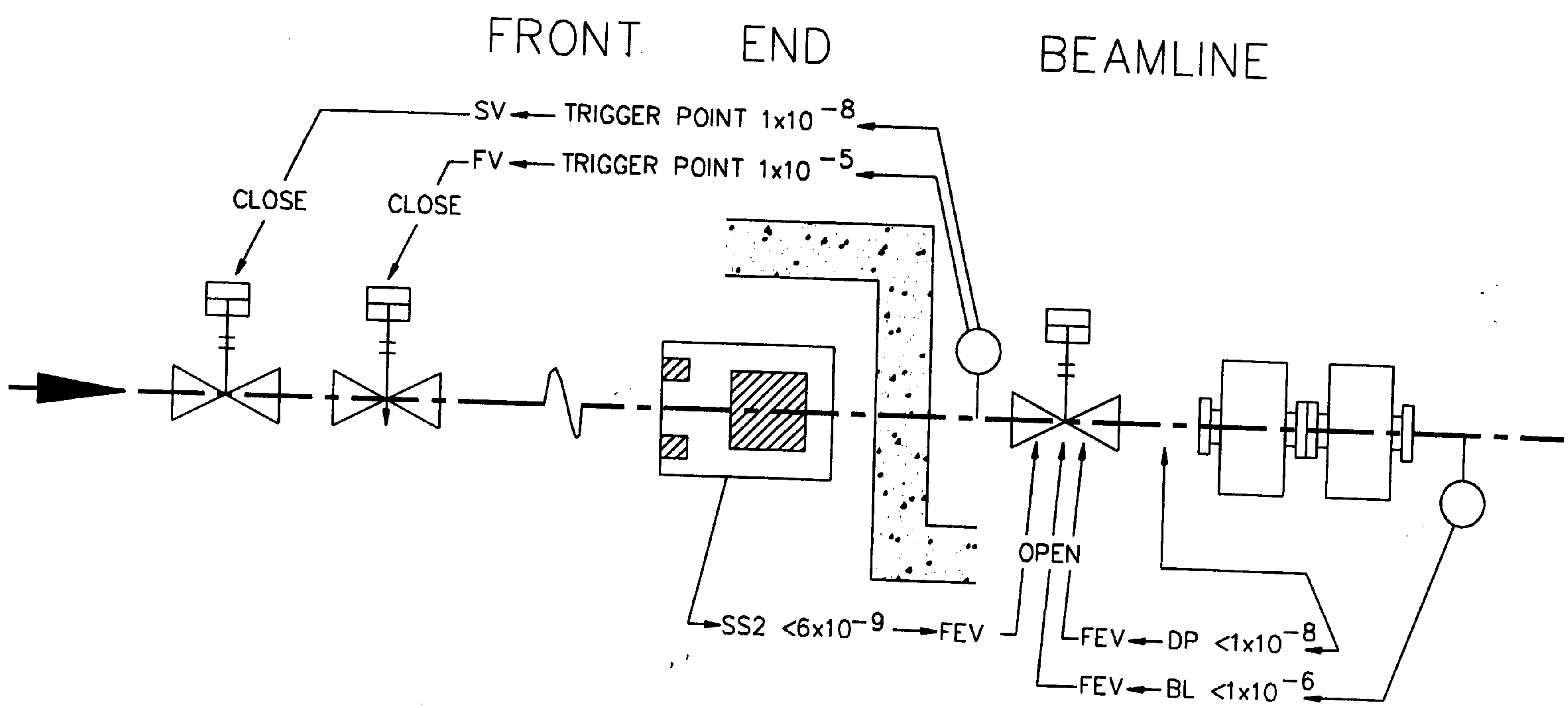
FRONT END
BEAMLINE
SV ← TRIGGER POINT 1x10 −8
FV ← TRIGGER POINT 1x10 −5
CLOSE
CLOSE
OPEN
SS2 <6x10−9 → FEV
FEV ← DP <1x10−8
FEV ← BL <1x10−6

Figure 1

2.0. Beamline Shielding

2.0.1 Sources of Radiation for Beamline Shielding
2.0.2. Shielding Metrology
2.0.3. First Optics Enclosure (FOE) - White Beam Hutch
2.0.4. Pink Beam Hutch
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2.0.8. Monochromatic Beam Transport
2.1. Typical First Optics Enclosure (FOE) - White Beam Hutch
2.2. Typical Pink Beam Hutch
2.3. Typical Monochromatic Beam Hutch
2.4. Typical White Beam Transport
2.5. Typical Pink Beam Transport
2.6. Typical Monochromatic Beam Transport
2.7. APS FOE and Experimental Hutches (section to be added later)
2.8. APS Shielded Monochromatic Transport and Pump Station (section to be added later)

Technical Analysis

APS has performed technical analysis of the shielding required under a variety of unusual operation conditions. These are summarized in sections 2.1 - 2.6

Design Stage and Schedule

The recommended shielding for various configurations of operation are now being evaluated from an engineering standpoint, and will be added to section 2.7 and 2.8. The results will lead to final shielding specifications for the hutches and the transports. This work is planned to be completed by May 1993.

2. Beamline Shielding

The shielding for the first optics enclosure (FOE), white beam, pink beam (reflected white beam), and monochromatic beam stations and transport lines shall be designed to keep the annual integrated dose equivalent at the shielding surface in occupied areas to less than 500 mrem. This design criteria is based on D.O.E. requirements (Radiation Control Manual, June 1992). For a 2000 hour operating year, this translates to a design criterion of 0.25 mrem/h. However, because it is highly unlikely that any user will be on the experimental floor at the shield surface for 2000 hours per year, and coupled with the fact that calculations were performed with conservative assumptions, annual dose equivalents received by individuals on the experimental floor should be well below 500 mrem.

2.01 Sources of Radiation for Beamline Shielding

Three sources of radiation should be considered for beamline shielding. They are:
1) gas bremsstrahlung
2) neutrons produced by gas bremsstrahlung
3) synchrotron radiation

Gas bremsstrahlung is produced by the interaction of the primary electron/positron beam with the residual gas in the Storage Ring vacuum chamber and is a major source of beam losses in storage rings. The interaction of the electron/positron with the gas molecules or ions takes place all around the Storage Ring, however, the photon intensity in the straight sections is very high. This is because in each interaction, the bremsstrahlung is produced in a narrow cone (characteristic emission angle = 1/g = 73 μradians for the APS) around the same direction and each contribution adds up resulting in a narrow monodirectional photon beam of high intensity. This narrow beam of bremsstrahlung travels down the synchrotron beamline and may be of major concern in the shielding design of the beamlines. The problem is aggravated with poor vacuum conditions in the Storage Ring.

The photons may be energetic enough to propagate an electromagnetic shower in any thick targets that they strike, or they can scatter off thin targets. In either case, this results in contributions to dose outside the transverse shielding of the beam transport, the optical enclosures/experimental stations, and the back walls of these stations. Because these photons are much more energetic than synchrotron radiation, they require far greater thicknesses of shielding material. For example, about 2 inches of lead will reduce the gas bremsstrahlung by a factor of 10, whereas it takes only about 3 mm of lead to reduce the 90° scattered synchrotron radiation (section 2.1) by the same factor. Monte-Carlo calculations are currently underway to determine the impact of gas bremsstrahlung on the shielding design of the beamlines. If it is determined that gas bremsstrahlung is a major concern in the shielding design of beamlines, additional local shielding around the target/scatterer will be specified.

In addition, if the target with which the gas bremsstrahlung interacts is sufficiently thick and the photons have energies above the photo-neutron production cross section, neutrons can also be produced. Analysis of neutron production is also being carried out. A foot of concrete will reduce the neutron and bremsstrahlung dose equivalent rate by a factor of 10 and 5, respectively.

Synchrotron radiation traveling down the beamline can scatter off any limiting aperture or any device that it strikes (e.g., monochromators, mirrors, masks, shutters, etc.) Thus the synchrotron beamline needs to be shielded against the scattered radiation.

The next section describes the shielding methodology. It must be pointed out that beam stops will be required in the forward direction inside the enclosures/experimental stations, however, they will not be addressed in this document. Other aspects of beamline shielding such as collimators for bremsstrahlung, treatment of joints, doors, feedthroughs for cables and pipes are also not addressed.

2.02

The "Photon" program[1,2] developed at the National Synchrotron Light Source was used to determine the shielding for the beamlines. This is a computer program that calculates dose in the following sequence:

1) calculation of photon flux as a function of energy and vertical opening angle of the synchrotron beam,
2) attenuation by filters,
3) a scattering process,
4) conversion from photon flux to dose.

Compton scattering is the primary mechanism for scattering at the large angles necessary to strike a shielding wall at or near normal incidence (where the effective elastically shielding thickness is a minimum). Low energy photons, which are more efficiently scattered through large angles, will not penetrate the shielding walls and therefore will not contribute to the dose outside the shielding.

In "Photon," the scatterer is assumed to be an isotropic point source and the total angularly integrated Compton cross section is used to calculate the scatter of the incident synchrotron spectrum from a target. In reality, there will be no point source of scatter in the beamlines, hence, "Photon" will overestimate the scattered intensities compared to that from an extended source.

"Photon" does not take into account the polarization dependence of the scattering. This will overestimate the scattered intensities in the horizontal plane while underestimating the scattered intensities in the vertical plane.

No consideration is given in the "Photon" program for electron-photon beam interactions, finite source size, or horizontal beam distribution. It must be pointed out that "Photon" uses the narrow beam attenuation coefficient for determining the dose outside the shielding. This can

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[1]D. Chapman, N. Gmur, N. Lazarz, and W. Thomlinson, "Photon: A Program for Synchrotron Radiation Dose Calculations," Nucl. Instr. and Meth. A266 191-194 (1988).

[2]E. Brauer and W. Thomlinson, "Experimental Verification of "Photon." A Computer Program for use in X-Ray Shielding," BNL 39541, Brookhaven National Laboratory, New York.

underestimate the dose because there will be build up from scattered photons. No build-up factor is used in the program. However, experimental data indicate that "Photon" overestimates the dose in the polarization plane.[3]

Sections 2.1 to 2.6 outline the shielding parameters and specifications for the beamlines. A maximum positron energy of 7 GeV, maximum current of 300 mA, and a maximum vertical divergence of 4/g were used for all calculations. Because the beamlines have to be shielded against scattered synchrotron radiation, "Photon" was run several times with different target materials (air, silicon, copper, and lead) and different target thicknesses to determine the material and thickness of the target that resulted in the highest scattered dose. Based on these runs, 30 cm of copper was chosen as the optimum target. Because enclosures/experimental stations will have optical elements such as mirrors, monochromators, safety shutters, and beam stops, all calculations for transverse shielding were based on using 30 cm of copper as the target (sections 2.1 - 2.3).

For beam transport pipes, a different approach is used. If ray traces indicate that the synchrotron beam could strike a high target (e.g., mask) or the beam pipe itself, during normal operating conditions or cases in of missteering, copper should be chosen as the optimum target (sections 2.4 - 2.6). If ray traces indicate that the synchrotron radiation could never strike a high-Z target in the transport pipe (this could be achieved with upstream collimation), 30 cm of air should be chosen as the optimum target. This would mean that no scattered radiation should be measured during normal operating conditions when the beam transport pipe is under good vacuum. However, if the vacuum in the pipe should be lost, then the synchrotron radiation could scatter off the air molecules. For the ID beamlines, calculations are done only for wigglers, which would result in more stringent specifications than for undulators. For wigglers, a critical energy of 32.6 keV, 32 poles, and a horizontal divergence of 2 mrad was used. For bending magnets, a critical energy of 19.5 keV and a horizontal divergence of 6 mrad was used. In addition, a safety factor of 2 for dose was incorporated into all the calculations.

The shielding specifications are based on model calculations and do not represent the final specifications for construction. After assessing the engineering needs, the APS will provide the final specifications.

The shielding specification in sections 2.1 to 2.6 can be used as long as the parameters used lie within the envelope of the specified parameters. The dose equivalent rates scale linearly with current, number of poles, and horizontal divergence. The dose equivalent rates follow an inverse square law with distance.

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[3] E. Brauer, "Health Physics Measurements Around the New F2 Wiggler Station at CHESS (Cornell University) ESRF Report.

The specifications of steel thicknesses for shielding are based on recommendations (for structural support) by a commercial supplier The shielding effect of steel has also been taken into account.

2.03 First Optics Enclosure/White Beam Hutches

The shielding parameters are specified in section 2.1. The copper scatterer is assumed to be at a distance of 29.45 m from the source. The calculations do not depend on this distance as long as all the radiation is taken into account by integrating over the full vertical extent of the beam. The energy range of the incident spectrum is 1-800 keV. The first and second tables specify the shielding requirements for the ID and bending magnet, respectively. The first column in each table specifies the wall under consideration. The second column shows the distance between the scatterer and the wall. The third, fourth, and fifth columns show the thickness of steel, lead, and steel required for each wall. The sixth column shows the dose equivalent rate (DER) at the shield surface for which the hutch wall has been shielded. The last column shows the effective tenth value layer (TVL) for lead, i.e., the thickness required to reduce the DER by a factor of 10. The lateral wall has been shielded for 0.25 mrem/h because a high occupancy can be expected outside this wall.
The roof has been shielded for 2.5 mrem/h since it is not expected to be occupied. Conservative calculations for skyshine (i.e., x-rays reflected back from the atmosphere to the experimental floor) indicate that the dose equivalent rates will be at least two orders of magnitude lower. So, the contribution from skyshine to the experimental floor will be less than 0.025 mrem/h.

The back walls of the hutch are thicker than the lateral walls by a tenth-value layer, because "Photon" underestimates the scattered intensities in the vertical plane and to account for the forward scattered photons, which are be more energetic than the laterally scattered ones. Inherent in this approach is the assumption that beam stops will be designed to stop both the forward directed gas bremsstrahlung and forward directed synchrotron radiation. Provisions should be made for additional shielding of the back walls, if beam stops do not intercept all the forward scattered radiation.

2.04 Pink Beam Hutches

It is difficult to generalize shielding for pink beam hutches, because the type of mirror used and the grazing angle of incidence can vary. Hence, the shielding specifications for pink beam hutches (section 2.2) has been given only as an example and is not to be used as a general case. In this example, a platinum mirror with a grazing angle of incidence of 0.15°and a cut-off energy of 32 keV, (reflectivity = 0.4) was used. However, for shielding calculations reflectivities of 1.0, 0.0164, and 0.0017 were used for photon energies in the range 1-50 keV, 50-80 keV, and 80 -100 keV, respectively. Hence, the results are conservative.

2.05 Monochromatic Beam Hutches

The determination of shielding for monochromatic beam hutches is not straight forward because any energy and bandwidth can be chosen. In addition, one must shield for harmonics as well. The shielding specifications in section 2.3 assume a monochromatic beam with a 0.1% bandwidth in the energy range of 1-300 keV. The photons in the energy range of 200 - 300 keV contribute the highest dose, hence a photon energy in this range was chosen with a 0.1% bandwidth, and the shielding was determined. A half-value layer (HVL) of lead, that is, the thickness required to reduce the dose by a factor of 2, was added to the thickness determined earlier to account for the harmonics. These new values are reported in column 4.

2.06 White Beam Transport

As mentioned in section 2.06, the calculations were done for two scatterers, 30 cm of copper and 30 cm of air. The beam pipe diameter is four inches (section 2-4). If ray traces indicate that the beam may strike a high-Z target in the beam pipe, the shielding in the second row of the tables should be used, because this will limit the dose equivalent rate to 0.25 mrem/h. If ray traces indicate that only during missteering could the synchrotron beam could strike a high-Z target in the beam pipe, then the shielding in the third row should be used. A dose equivalent rate of 2.5 mrem/h at the shield surface can be tolerated because it will last only during missteering and not persist for 2000 hours.

If ray traces indicate that the synchrotron beam will not strike any high-Z material in the beam pipe, then technically no shielding is required for the beam pipe. However, it is possible to lose the vacuum in the beam pipe, and, if this happens, the synchrotron radiation could scatter off air molecules. In this case, the shielding in row 5 should be used.

2.07 Pink Beam Transport

A similar calculation was carried out for pink beam transport (section 2.5) was done for white beam transport. The pink beam transport shielding specifications are given only as an example and should not be used as a general case.

2.08 Monochromatic Beam Transport

A similar calculation was carried out for monochromatic beam transport (section 2.6) as for white beam transport.

2.1. Typical First Optical Enclosure (FOE) - White Beam Hutch

Shielding Parameters

The following parameters were used to determine the shielding for the walls and the roof of the FOE and the white beam stations at the ID beamlines.

Positron energy	7.0 GeV	
Positron current	300 mA	
Photon energy range	1 - 800 keV	
Vertical divergence	$\Psi = \pm 4/\gamma$	
Scatterer	300 mm Cu at a distance of 29.45 m from the source	
	Insertion Device (ID)	*Bending Magnet (BM)*
Critical energy	32.6 keV	19.5 keV
Number of poles	32	1
Horizontal divergence	2 mrad	6 mrad

Specifications

Insertion Device (ID)

Wall	Distance[1] (m)	Shielding Material steel (mm)	+lead (mm)	+steel (mm)	DER[2] (mrem/h)	TVL[3] (mm)
Lateral	1.0	6.35	12.8	6.35	0.25	3.1
Roof	1.5	3.2	9.9	3.2	2.5	2.7
Back	1.0	6.35	15.9	6.35		

Bending Magnet (BM)

Wall	Distance (m)	Shielding Material steel (mm)	+lead (mm)	+steel (mm)	DER (mrem/h)	TVL (mm)
Lateral	1.0	3.2	5.3	3.2	0.25	1.3
Roof	1.5	3.2	3.7	3.2	2.5	1.1
Back	1.0	3.2	6.6	3.2		

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[1] Distance from scatterer to wall
[2] DER = Dose Equivalent Rate at the shielding surface
[3] TVL = Tenth Value Layer (thickness of Pb required to reduce the dose equivalent rate by a factor of ten)

2.2. Typical Pink Beam Hutch

Shielding Parameters

The following parameters were used to determine the shielding for the walls and the roof of the pink beam stations at beamlines with reflected beams.

Positron energy	7.0 GeV
Positron current	300 mA
Photon energy range	1 - 50 keV (R=1), 50 - 80 keV (R=0.0164), 80 -100 keV (R=0.0017) R = reflectivity of the mirror
Vertical divergence	$\Psi = \pm 4/\gamma$
Scatterer	300 mm Cu
	Insertion Device (ID)
Critical energy	32.6 keV
Number of poles	32
Horizontal divergence	2 mrad

Specification **Insertion Device (ID)**

Wall	Distance[1] (m)	Shielding Material steel (mm)	+lead (mm)	+steel (mm)	DER[2] (mrem/h)	TVL[3] (mm)
Lateral	1.0	3.2	4.1	3.2	0.25	1.0
Roof	1.5	3.2	2.9	3.2	2.5	0.9
Back	1.0	3.2	5.1	3.2		

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[1] Distance from scatterer to wall

[2] DER = Dose Equivalent Rate at the shielding surface

[3] TVL = Tenth Value Layer (thickness of Pb required to reduce the dose equivalent rate by a factor of ten)

2.3. Typical Monochromatic Beam Hutch

Shielding Parameters

The following parameters were used to determine the shielding for the walls and the roof of the monochromatic beam stations at beamlines with monochromatic beams.

Positron energy	7.0 GeV	
Positron current	300 mA	
Photon energy range	1 - 300 keV (0.1%bandwidth)	
Vertical divergence	$\Psi = \pm 4/\gamma$	
Scatterer	300 mm Cu	
	Insertion Device (ID)	*Bending Magnet (BM)*
Critical energy	32.6 keV	19.5 keV
Number of poles	32	1
Horizontal divergence	2 mrad	6 mrad

Specifications

Insertion Device (ID)

Wall	Distance[1] (m)	Shielding Material steel (mm)	+lead (mm)	+steel (mm)	DER[2] (mrem/h)	TVL[3] (mm)
Front + Lateral	1.0	3.2	8.9	3.2	0.25	2.7
Roof	1.5	3.2	4.9	3.2	2.5	2.9
Back	1.0	3.2	11.6	3.2		

Bending Magnet (BM)

Wall	Distance (m)	Shielding Material steel (mm)	+lead (mm)	+steel (mm)	DER (mrem/h)	TVL (mm)
Front + Lateral	1.0	3.2	3.5	3.2	0.25	1.1
Roof	1.5	3.2	2.0	3.2	2.5	1.0
Back	1.0	3.2	4.6	3.2		

[1] Distance from scatterer to wall
[2] DER = Dose Equivalent Rate at the shielding surface
[3] TVL = Tenth Value Layer (thickness of Pb required to reduce the dose equivalent rate by a factor of ten)

2.4. Typical White Beam Transport

Shielding Parameters

The following parameters were used to determine the shielding for the white beam transport lines.

Positron energy	7.0 GeV	
Positron current	300 mA	
Photon energy range	1 - 800 keV	
Vertical divergence	$\Psi = \pm 4/\gamma$	
Ø of the beam pipe	4"	
	Insertion Device (ID)	*Bending Magnet (BM)*
Critical energy	32.6 keV	19.5 keV
Number of poles	32	1
Horizontal divergence	2 mrad	6 mrad

Specifications

Insertion Device (ID)

Scatterer	Shielding Material			DER
	steel (mm)	+lead (mm)	+steel (mm)	(mrem/h)
300 mm Cu	6.35	21.2	6.35	0.25
300 mm Cu	6.35	18.0	6.35	2.5
300 mm air	6.35	13.2	6.35	0.25
300 mm air	6.35	10.6	6.35	2.5

Bending Magnet (BM)

Scatterer	Shielding Material			DER
	steel (mm)	+lead (mm)	+steel (mm)	(mrem/h)
300 mm Cu	3.2	9.3	3.2	0.25
300 mm Cu	3.2	7.6	3.2	2.5
300 mm air	3.2	6.0	3.2	0.25
300 mm air	3.2	4.9	3.2	2.5

2.5. Typical Pink Beam Transport

Shielding Parameters

The following parameters were used to determine the shielding for the walls of the pink beam transport lines (beamlines with reflected beams).

Positron energy	7.0 GeV
Positron current	300 mA
Photon energy range	1 - 50 keV (R=1), 50 - 80 keV (R=0.0164), 80 -100 keV (R=0.0017) R = reflectivity of the mirror
Vertical divergence	$\Psi = \pm 4/\gamma$
Ø of the beam pipe	4"
	Insertion Device (ID)
Critical energy	32.6 keV
Number of poles	32
Horizontal divergence	2 mrad

Specifications **Insertion Device (ID)**

Scatterer	Shielding Material steel (mm)	+lead (mm)	+steel (mm)	DER (mrem/h)
300 mm Cu	3.2	6.7	3.2	0.25
300 mm Cu	3.2	5.6	3.2	2.5
300 mm air	3.2	5.0	3.2	0.25
300 mm air	3.2	4.0	3.2	2.5

2.6. Typical Monochromatic Beam Transport

Shielding Parameters

The following parameters were used to determine the shielding for the walls of the monochromatic beam transport lines.

Positron energy	7.0 GeV	
Positron current	300 mA	
Photon energy range	1 - 300 keV (0.1% bandwidth)	
Vertical divergence	$\Psi = \pm 4/\gamma$	
Ø of the beam pipe	4"	
	Insertion Device (ID)	*Bending Magnet (BM)*
Critical energy	32.6 keV	19.5 keV
Number of poles	32	1
Horizontal divergence	2 mrad	6 mrad

Specifications

Insertion Device (ID)

Scatterer	Shielding Material			DER
	steel (mm)	+lead (mm)	+steel (mm)	(mrem/h)
300 mm Cu	6.35	15.5	6.35	0.25
300 mm Cu	6.35	12.8	6.35	2.5
300 mm air	3.2	9.1	3.2	0.25
300 mm air	3.2	6.2	3.2	2.5

Bending Magnet (BM)

Scatterer	Shielding Material			DER
	steel (mm)	+lead (mm)	+steel (mm)	(mrem/h)
300 mm Cu	3.2	6.3	3.2	0.25
300 mm Cu	3.2	5.2	3.2	2.5
300 mm air	3.2	4.4	3.2	0.25
300 mm air	3.2	3.3	3.2	2.5

3. Filters

3.1. Filter assembly

3.2. Filter material

Technical Analysis

The details of a filter (material and dimensions) are closely linked to the nature of the experiment being planned by the CATs. We suggest that the CATs design the filter material to meet their needs. It should be recognized that filter failure during operation can lead to damage of equipment in the beamline.
In section 3.1 we present a generic design for the filter assembly that the CATs could use in this preliminary design of the beamline. Section 3.2 provides filter properties essential for the selection of the material.

Design Schedule

The APS is pursuing detailed analysis of filter material including both thermal and mechanical considerations. This will be available in May 1993.

3. Filters

Filters in beamlines are primarily used to reduce the bandpass of the beam and thus the power load on the elements that interact with the beam (windows, monochromator crystals, etc.). For x-ray beamlines, a combination of high pass (filter foils) and low pass filters, such as a beam-deflecting mirror is very effective. These combinations are also able to suppress higher order reflections in the monochromatic beam.

3.1. Filter Assembly

General description

The filter assembly is designed to provide a modular beamline filtering system. The assembly consists of a housing with a selection of linear filter mounts. The assembly or the linear filter mounts can be placed in every vacuum segment of the user's beamline. For ease of replacement, the filter foils are mounted on standardized filter frames. The filter frames can carry up to 5 different filter foils. The filters are linearly moved into the beam by a light load actuator. The positions of the filters must be interlocked with the beam. This protects the filter frames from being hit by the beam. The filter frames are directly cooled. In the case of radiation cooling, the surrounding vacuum chamber is protected by water cooled-radiation shielding or is directly cooled by attached water cooling.

Specifications

Filter assembly tank
Two ultra high vacuum (UHV) compatible vacuum tanks with two 8" O.D. flanges for filter inserts from the top are under design. The length of one tank is 325 mm. The I.D. of the entrance and exit flange is 4". Ports for pumping (170 l/sec) and viewing the filter foils are supplied. Figure 2 shows the two tanks for a maximum of four assemblies.

Filter assembly
Two types of filter assemblies are in the design phase: a single insert type and a double insert type based on the APS light load actuator with a stepping motor drive. In five different places, up to two filter foils can be mounted on a water-cooled frame. The frame can be moved linearly to different filter slots. The sizes of the filters are 15 x 80 mm. The drive is supplied with interlock switches to prevent accidental irradiation of the frame. The filters can be positioned to within 0.1 mm. Figure 3 shows the water-cooled frame with a linear drive and with radiation shielding.

3.2. Filter Material

The choice of filter material is primarily determined by the transmission energy range, which is defined by the photo absorption coefficient of the material and the thickness of the filter. Figures 4 to 9 show transmission curves for different materials that can be used as x-ray high-pass filters. The filter materials for high power insertion device beamlines have to be carefully analyzed and chosen for the ability to be cooled. Both cooling schemes (conduction cooling and radiation cooling) have to be taken into account because filters often operate at high temperatures. At the APS, failure criteria and an analysis method for filter and window assemblies are under development.

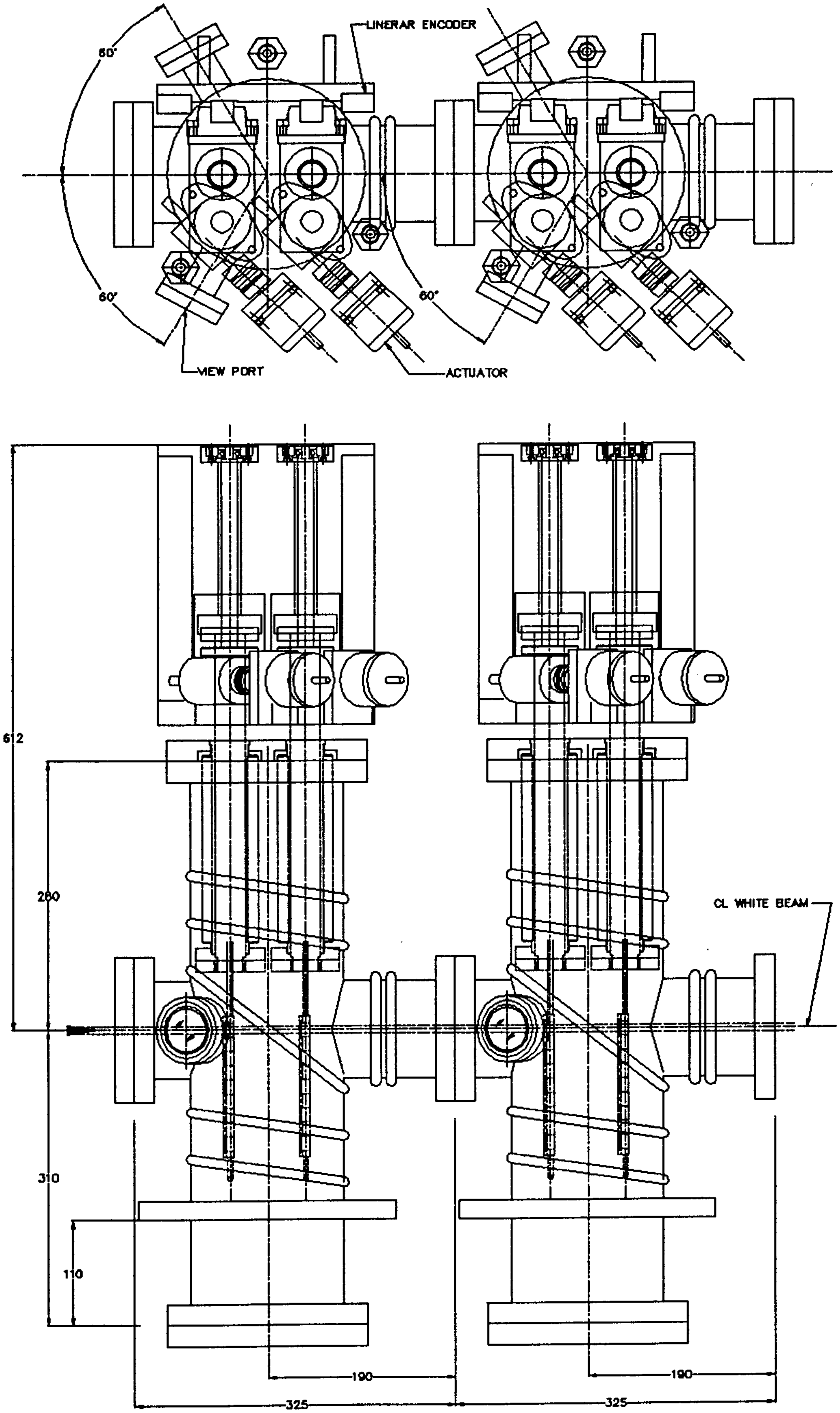


Figure 2 APS BEAM LINE FILTER ASSY
2/20/93

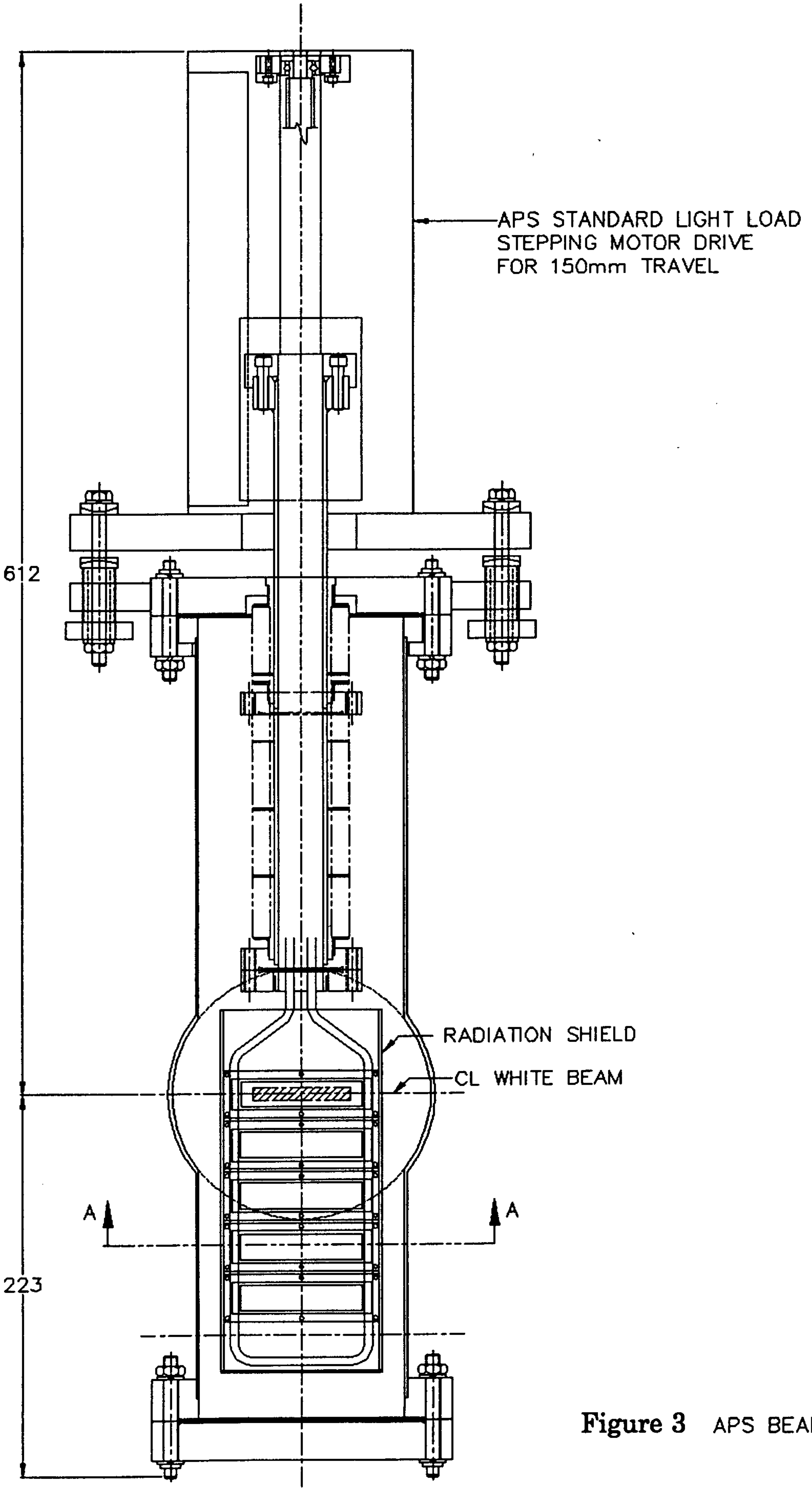
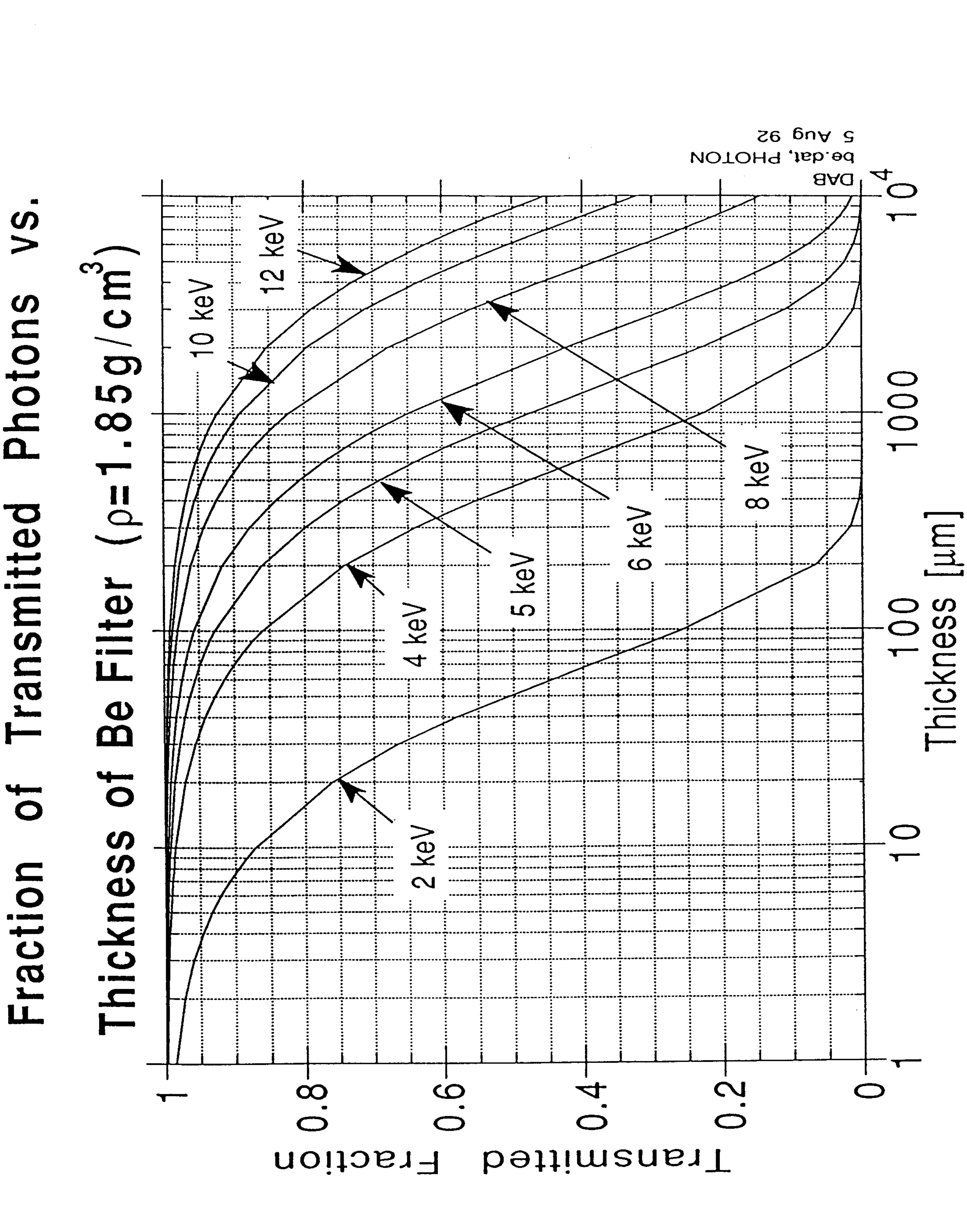
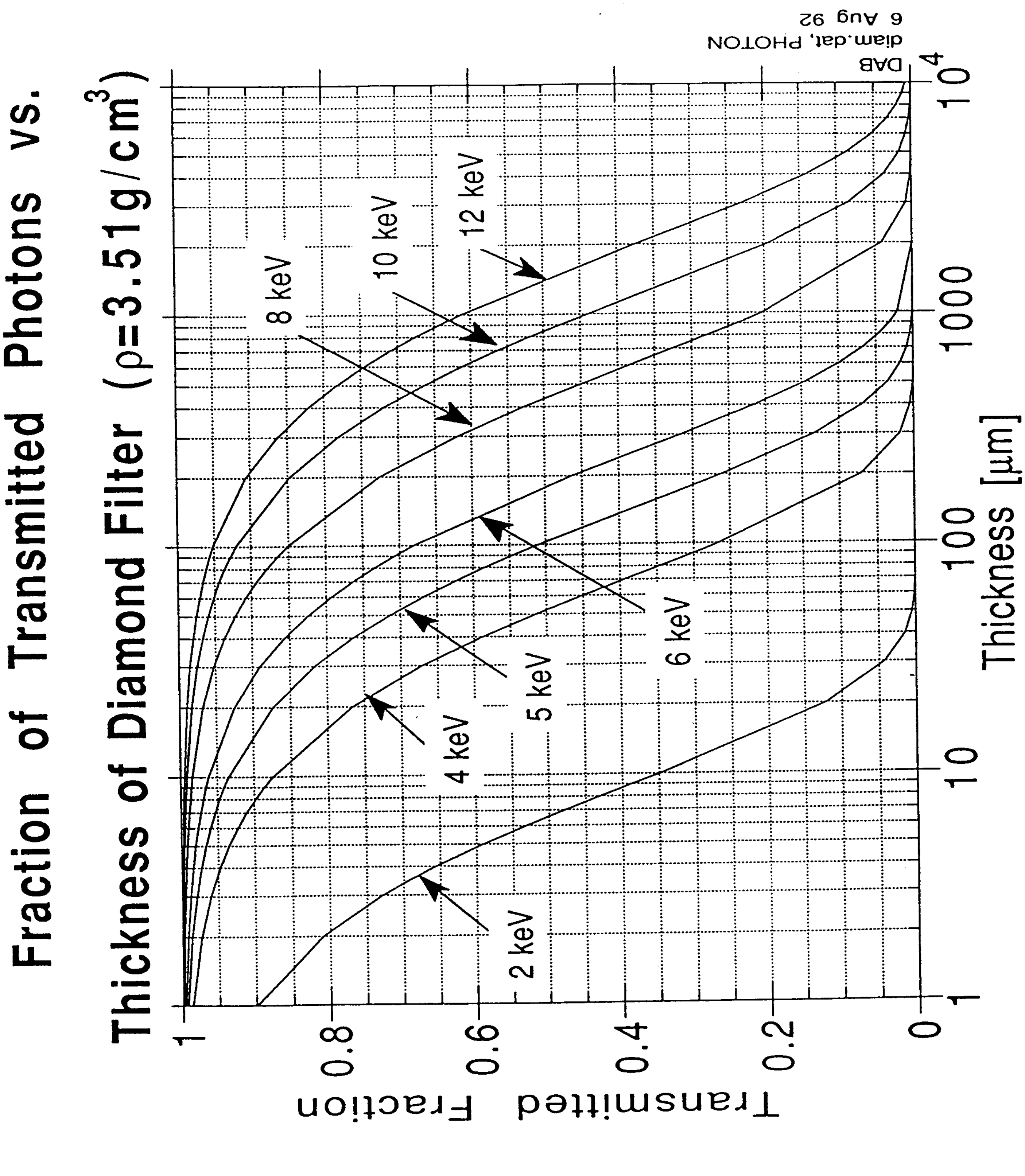


Figure 3 APS BEAM LINE FILTER



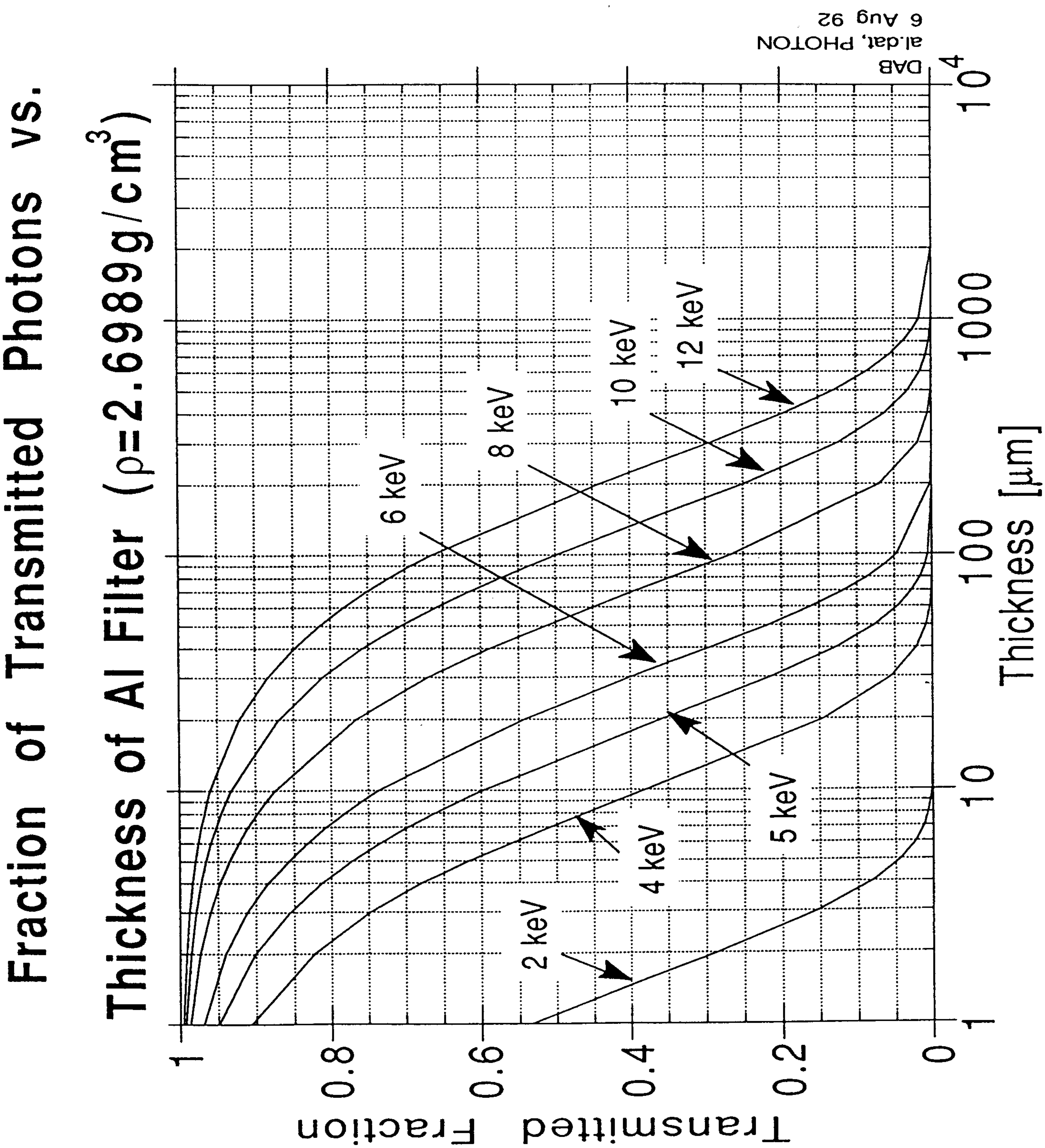
Fraction of Transmitted Photons vs.
Thickness of Be Filter (ρ=1.85g/cm^3)
Transmitted Fraction
Thickness [μm]
2 keV
4 keV
5 keV
6 keV
8 keV
10 keV
12 keV
DAB
be.dat, PHOTON
5 Aug 92

Figure 4



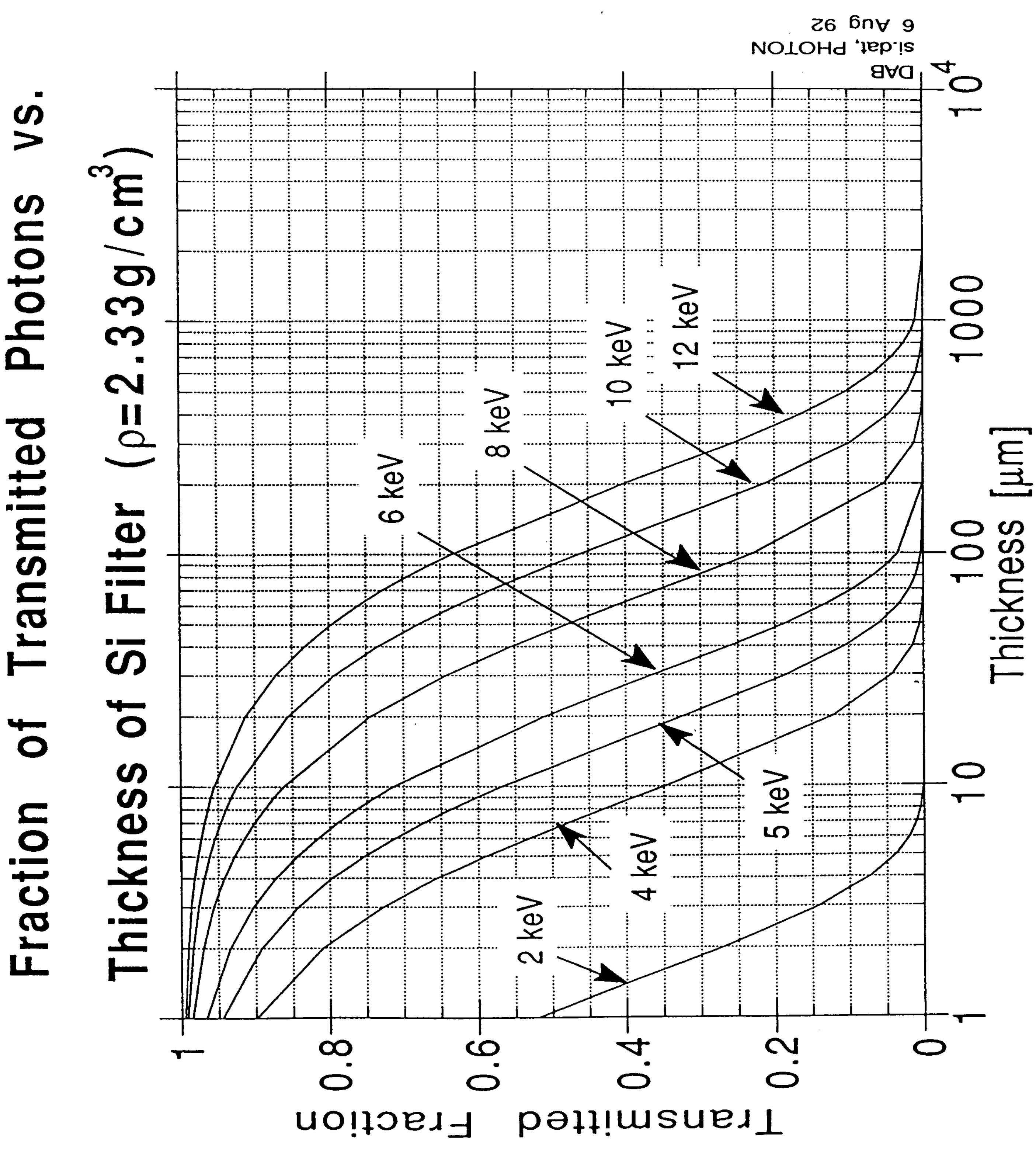
Fraction of Transmitted Photons vs. Thickness of Diamond Filter (ρ=3.51g/cm^3)
Transmitted Fraction
Thickness [µm]
1
0.8
0.6
0.4
0.2
0
1
10
100
1000
10^4
2 keV
4 keV
5 keV
6 keV
8 keV
10 keV
12 keV
DAB
diam.dat, PHOTON
6 Aug 92

Figure 5



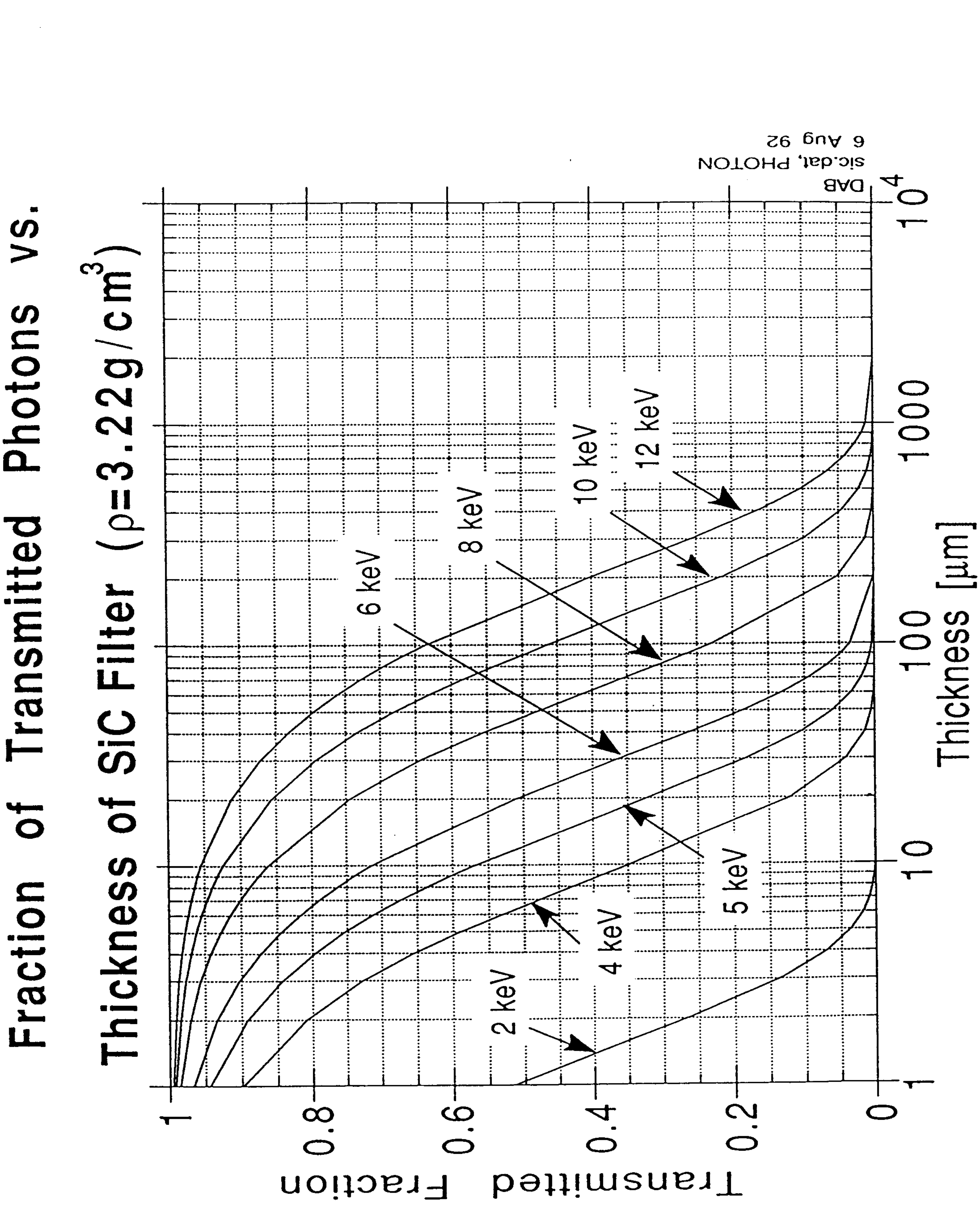
Fraction of Transmitted Photons vs.
Thickness of Al Filter (ρ=2.6989g/cm^3)
Transmitted Fraction
Thickness [μm]
1
0.8
0.6
0.4
0.2
0
1
10
100
1000
10^4
2 keV
4 keV
5 keV
6 keV
8 keV
10 keV
12 keV
DAB
al.dat, PHOTON
6 Aug 92

Figure 6



Fraction of Transmitted Photons vs.
Thickness of Si Filter (ρ=2.33g/cm^3)
Transmitted Fraction
Thickness [µm]
2 keV
4 keV
5 keV
6 keV
8 keV
10 keV
12 keV
DAB
si.dat, PHOTON
6 Aug 92

Figure 7



Fraction of Transmitted Photons vs.
Thickness of SiC Filter (ρ=3.22g/cm^3)
Transmitted Fraction
Thickness [µm]
0
0.2
0.4
0.6
0.8
1
1
10
100
1000
10^4
2 keV
4 keV
5 keV
6 keV
8 keV
10 keV
12 keV
DAB
sic.dat, PHOTON
6 Aug 92

Figure 8

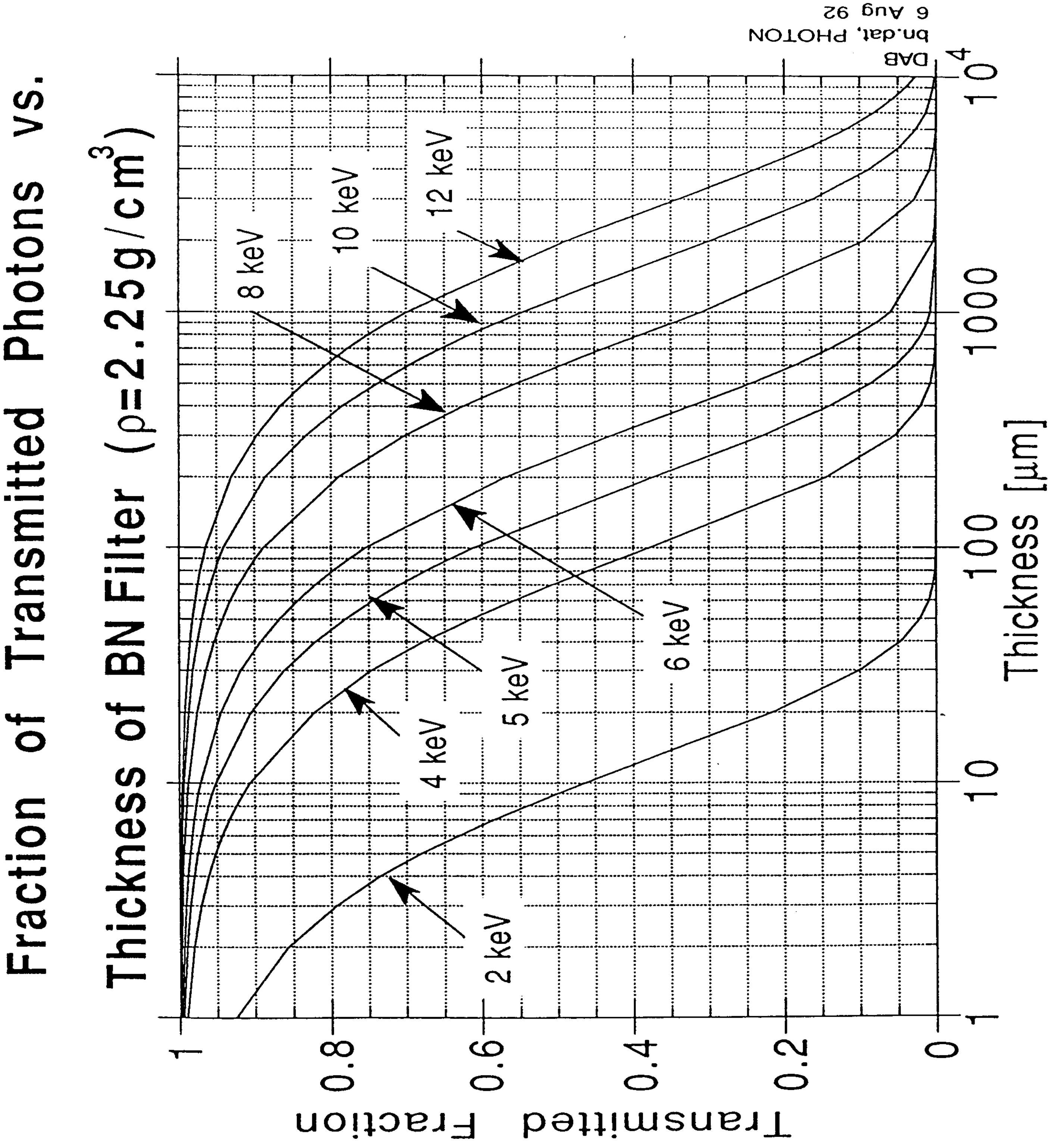

Fraction of Transmitted Photons vs.
Thickness of BN Filter (ρ=2.25g/cm^3)
Transmitted Fraction
Thickness [μm]
2 keV
4 keV
5 keV
6 keV
8 keV
10 keV
12 keV
DAB
bn.dat, PHOTON
6 Aug 92

Figure 9

4. Windows

4.1. Be - windows
4.2. C - windows
4.3. Differential pump

Technical Analysis

At APS, failure criteria and an analysis method for filter and window asemblies and their cooling schemes are under development. Reports on the analysis will be made available to all CATs by May 1993.

4. Windows

Windows are used to separate beamline sections with different vacuum or pressure conditions (UHV - HV - atmospheric pressure). For the transmission of the windows, the same design criteria are used as for the filters. The vacuum tightness of the windows (<1x10^{-10} torrl/sec) together with the pressure difference at a transition from vacuum to atmosphere are additional complications of the window design. The main difficulty is introduced by the high heat load of the ID beams, which can introduce power loads in the kW range. In these cases, windows have to be protected by filters, which have to take a large amount of the power load. Such filter - window combinations severely limit the availability of radiation below 5 - 6 keV. For many CATs, we strongly recommend the use of windowless configurations on ID beamlines to retain the flexibility of using the entire energy spectrum.

It should also be pointed out that if the CAT's interest is primarily in the hard x - ray range (>10 keV), the use of Al windows may be appropriate and should altriate many design problems of filters and windows.

At APS, failure criteria and an analysis method for filter and window assemblies and their cooling schemes are under development.

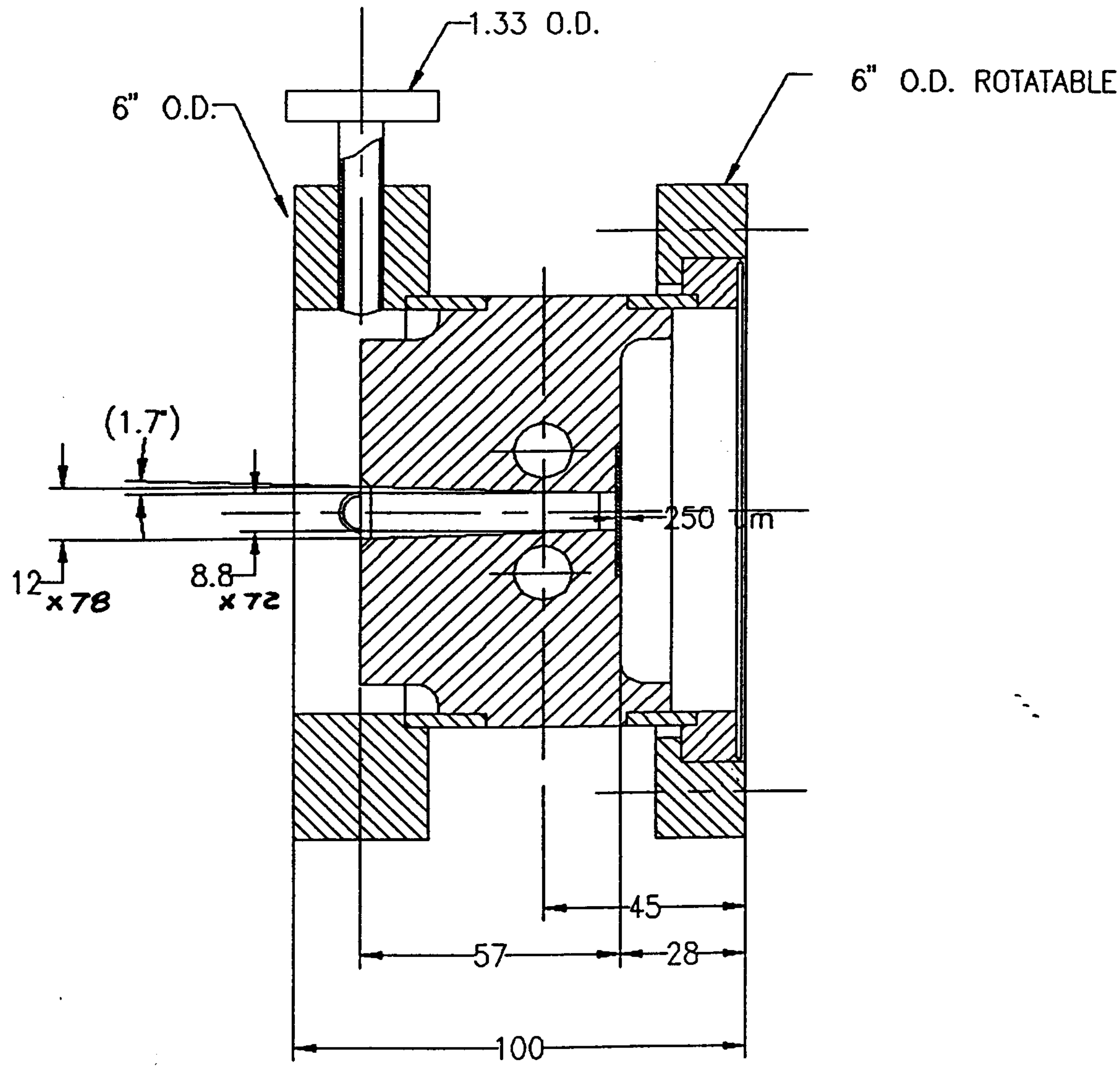
4.1. Be - windows

For windows low-Z materials are preferred. Beryllium is a very common window material. In conventional synchrotron applications better than 99.8% pure special grade Be of 250 µm (10 mil) thickness foil is utilized as the window material and is metallurgically bonded to a water-cooled copper Conflat flange. Several reputable US and European manufacturs of Be windows now exist from which one can purchase ready-made window assemblies with 125 to 250 µm thickness that are warranted to be vacuum tight. Windows are assumed to fail under several scenarios. These include severe vacuum incursions, an atmospheric shock wave being the worst possible case; oxidization of Be itself from the vacuum gas impurities; and, deterioration of the window bond itself. The most recognized and studied case of window failures in open literature (Asaoka et al., Rev. Sci. Instrum. Vol. 63, No. 1, pp 473-476, Jan 1992) is however the thermally induced failures under x-ray heating of the Be foil. Structural failure of the thin Be foil under heating and the resulting thermal stresses have been poorly understood and postulated. The conventional criterion that when the thermally induced shear stress becomes half of the foil's yield has underpredicted window failures. Depending on the usage and power source etcetera, the window failures may occur as sudden cracking under heat, gradual evaporative erosion, and elastic/plastic buckling. The latter scenario has been experimentally observed and we can verify it analytically.

Our current analyses and understanding of the thermal behaviour of the cooled, whitebeam APS front end Be window lead us to believe that the window should be protected by at least a 300 μm thick carbon (graphite) filter, should not be allowed to absorb more than 60 W total power, and the window temperature should not exceed 250ºC.

Here we present a set of window designs for various uses.

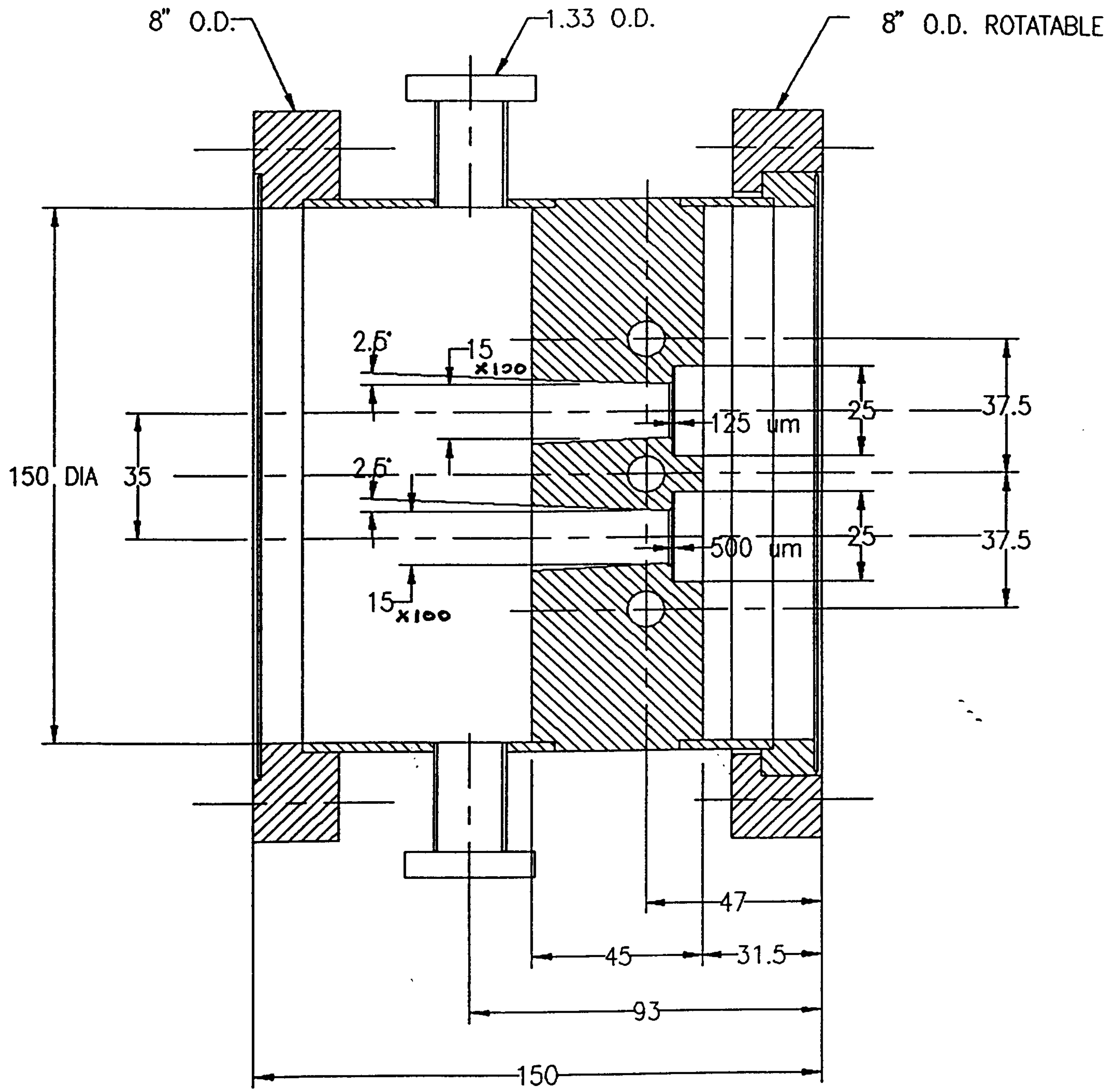
1. A window suitable for white radiation from an APS wiggler (with K=14, 7 GeV and 100 mA). This can also be used for monochromatic radiation from APS IDs.
2. A double window to deliver both white and/or monochromatic radiation from either an APS ID or bending magnet source.
3. A window suitable for transmitting bending magnet white radiation with a horizontal width of approximately 110 mm.



WIG. WHITE & WIG/UND MONO. WINDOW

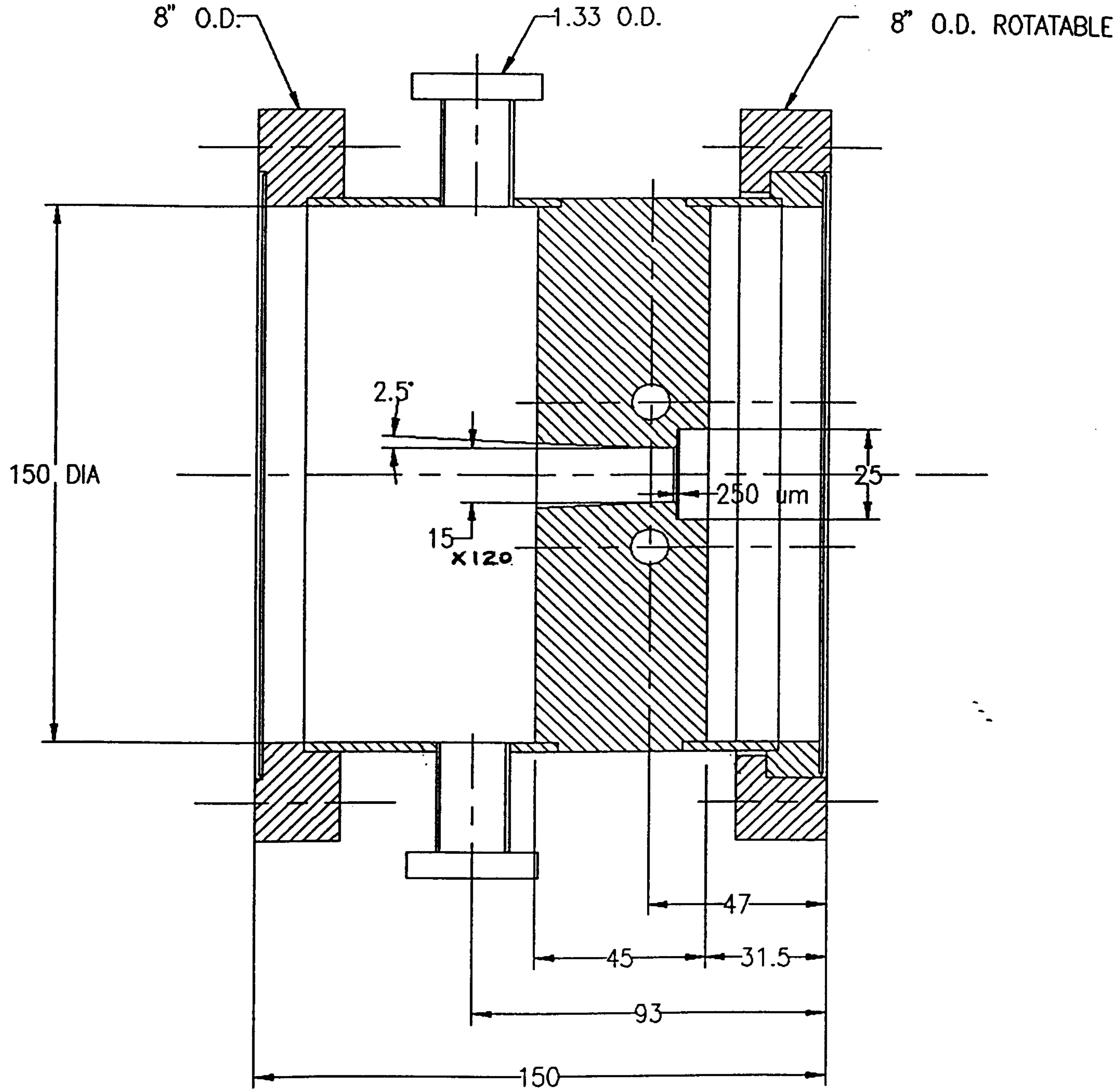
Figure 10

W3S1.DWG 02-19-1993



MONO. & WHITE DUAL WINDOW W5S1.DWG 02-19-1993

Figure 11



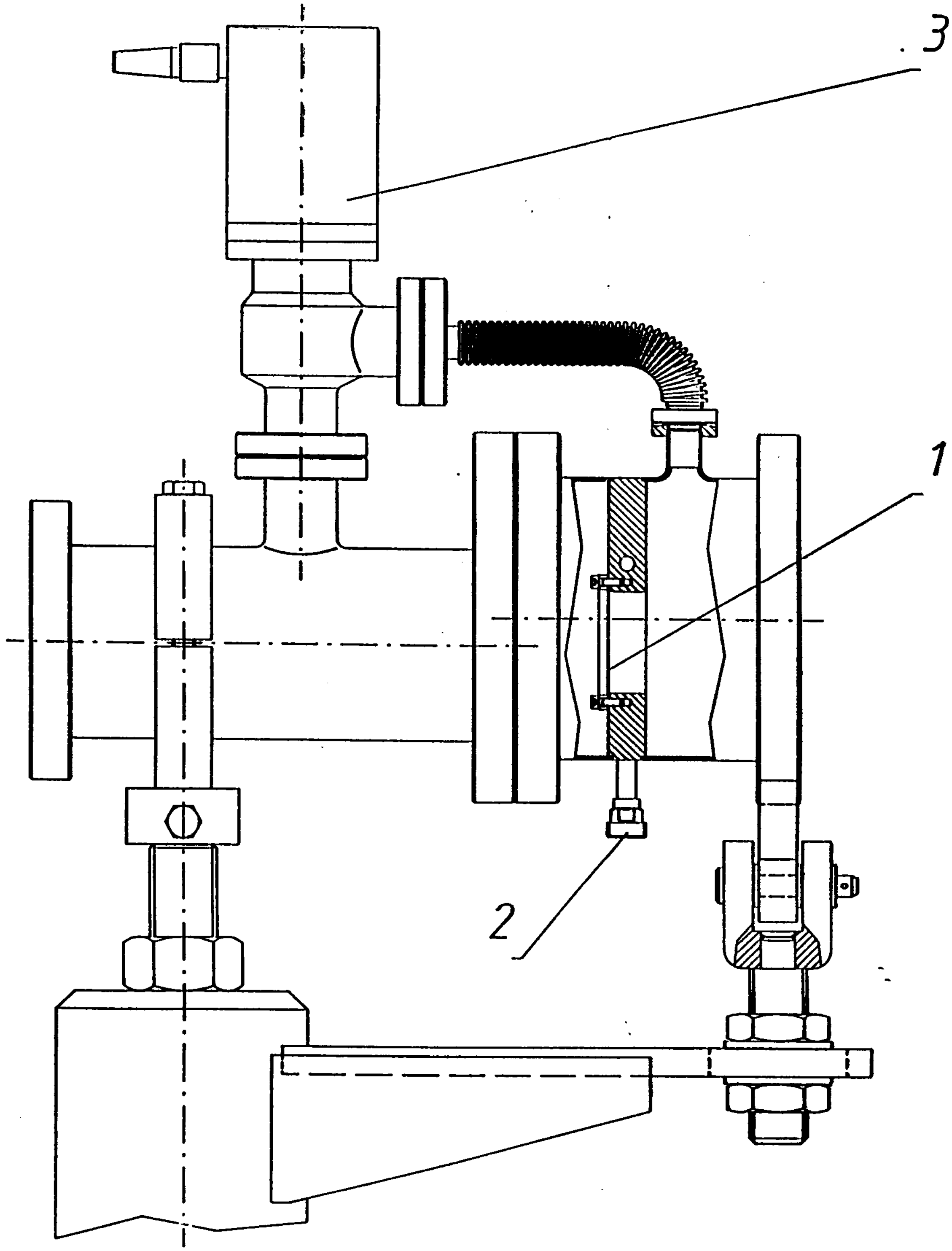
BM WHITE BEAM WINDOW W4S1.DWG 02-19-1993

Figure 12

4.2. C - windows

4.2.1. Carbon foil windows

Carbon foil windows consists mostly of a thin pyrolytic graphite foil that is mounted on a water-cooled copper block. These windows cannot handle pressure differences in the range of one atmosphere. Also, accidental venting will destroy these windows. They are mainly used as contamination barriers to separate UHV beamline sections from sections with relative bad vacuum conditions (~10^{-5} torr). A detailed analysis of the vacuum separation properties of thin carbon foils was carried out by Lagomarsino et al. [Nucl. Inst. Meth. A307 (1991) 309-311]. Figure 13 shows the design of such window for a high power wiggler beamline at HASYLAB; (1) is the carbon foil (50 mm x 80 mm and 130 μm thick). The foil is clamped on a water-cooled copper block(2). The bypass valve (3) is used for pump down and venting.



Carbon foil window

Contamination barrier window for high power x-ray beamlines

1 **Carbon foil (50 x 80 mm, 130 μm thick)**
2 **Water-cooled Cu - Block**
3 **Vacuum bypass with valve**

Figure 13

4. 3. Differential Pump

Differential pumps make use of the good vertical collimation of the synchrotron radiation beam. It is possible to get several orders of magnitude pressure difference in the high vacuum range.
Figure 14 shows the standard APS design for windowless operation. With a minimal aperture of 10 x 78 mm, two 170 l/s ion pumps, and a total length of ~ 1 m, a pressure difference of two orders of magnitude is achieved. With its narrow aperture this device gives good performance in delay of shock waves in case of accidental venting.

A prototype differential pump similar to the one shown in figure 14 has been built and successfully tested by the APS. A pressure differential of more than two orders of magnitude has been reached with the aperture of 10 x 78 mm.

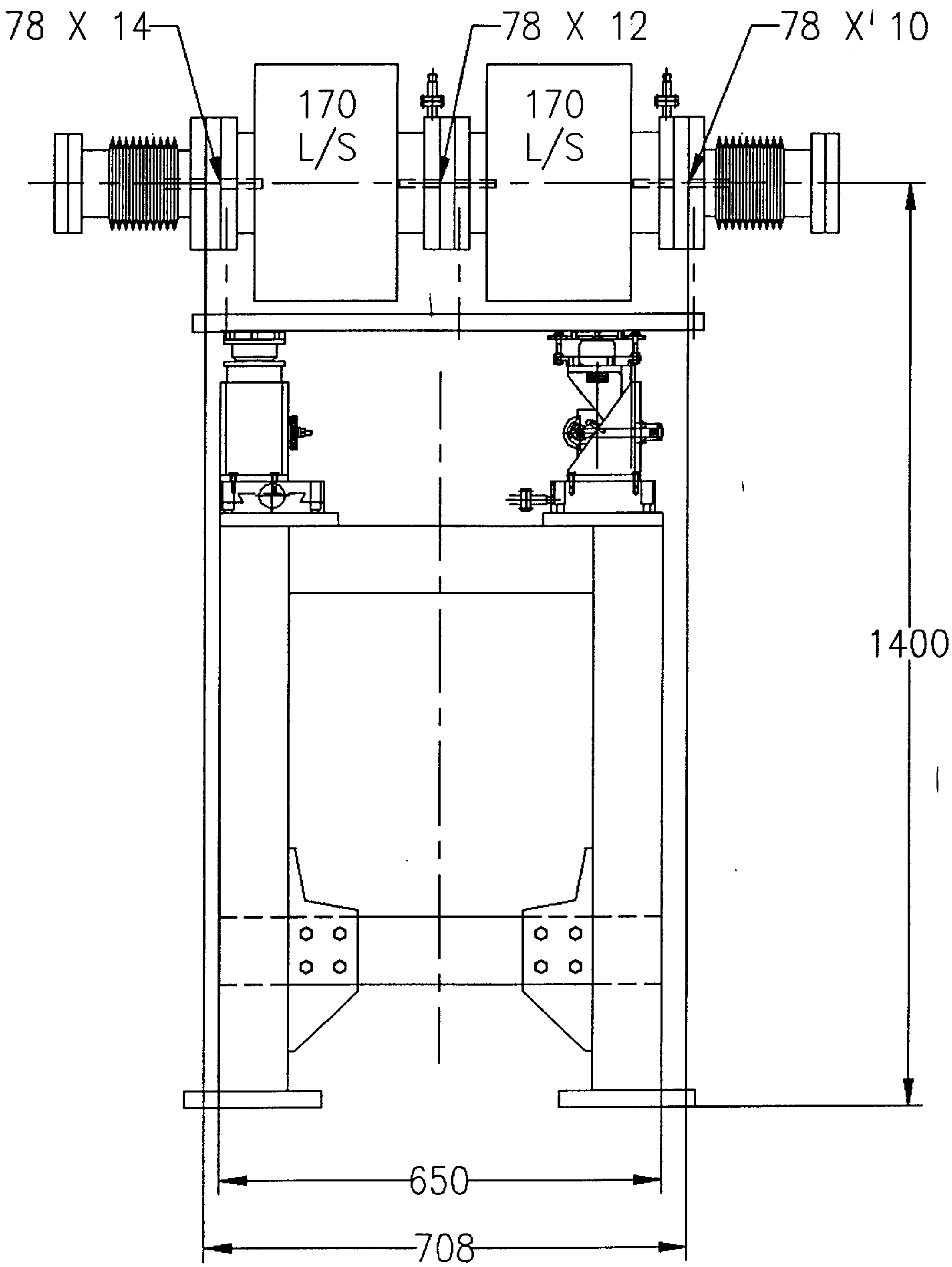


Figure 14

5. Slits

5.1.1. White beam slits - insertion device
5.1.2. White beam slits - bending magnet
5.2. Monochromatic beam slits

<u>Design Status and Schedule</u>

The design of slits and the choice of the material for their construction is closely related to their application. The CATs will have to participate closely in slit designs. For the present, the APS has put much emphasis on the power handling issue related to slit designs. These designs are not likely to meet all user needs. More work will be scheduled in this area as users provide more input to the APS during the beamline preliminary design phase.
In sections 5.1.1 and 5.1.2, the currently designed APS white beam slits for the insertion device and the bending magnet source are included along with specifications. The APS is currently working on its fabrication procedures to develop a prototype to be completed by the end of 1993.
In section 5.2 a monochromatic slit has been specified.

5.1.1. APS ID White Beam Slits

- Horizontal and vertical slits
- White beam compatible
- Four independent precision high load actuators
- Cooling for structural, vibrational, and thermal stability
- UHV compatible
- Provide for closed aperture

The APS white beam slits provide for precise aperture for the white synchrotron radiation. APS standard high load stepping linear actuator modules are used with horizontal and vertical slits. Each of the four masks in the slit assembly is independently movable. The beam intercepts the slits with a grazing incidence. Water-cooled copper foam removes the heat from the slit masks. The masks have been designed so that a pair of slits can be removed through a single vacuum port.

Specifications:

- Slit positional resolution:	2 μm
- Slit positional reproducibility:	5 μm
- Vertical aperture:	0 - 30 mm
- Horizontal aperture:	0 - 100 mm
- Grazing incidence angle:	3° (typical)
- Vacuum tank flanges:	6 inch
- Vacuum tank length:	< 1500 mm
- Actuator:	Standard APS heavy load stepping linear actuator
- Actuator drive:	Stepping motor with linear encoder
- Actuator maximum speed:	20 mm/min
- Encoder	Linear encoder

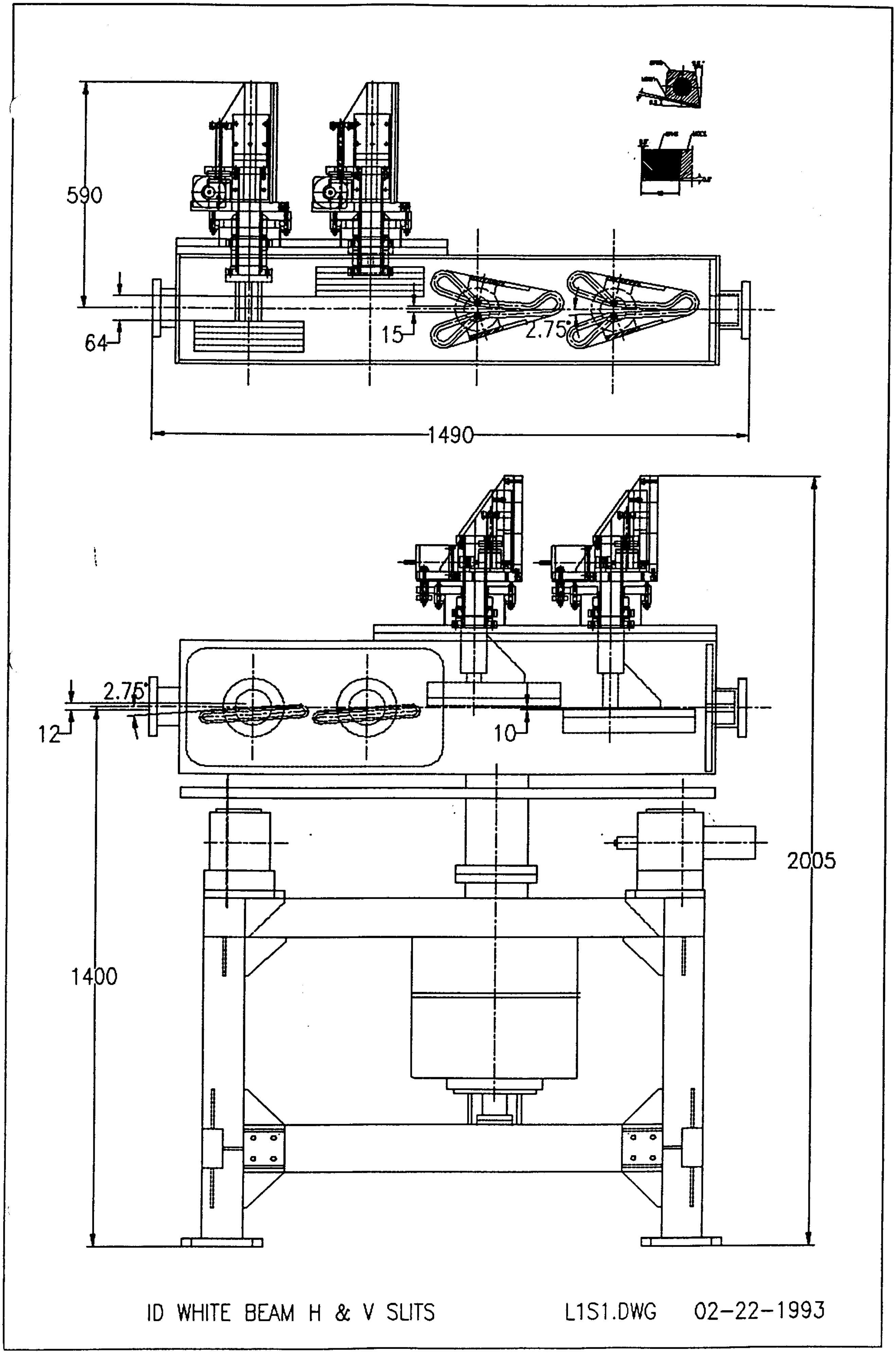

590
64
15
2.75°
1490
2.75°
12
10
2005
1400
ID WHITE BEAM H & V SLITS
L1S1.DWG
02-22-1993

Figure 15

5.1.2. APS BM White Beam Slits

- Horizontal and vertical slits
- White beam compatible
- Four independent precision light load actuators
- Cooling for structural, vibrational, and thermal stability
- UHV compatible
- Provide for closed aperture

The APS white beam slits provide for precise aperture for the white synchrotron radiation. APS standard light load stepping linear actuator modules are used with horizontal and vertical slits. Each of the four masks in the slit assembly is independently movable. The beam intercepts the slits with a normal incidence. Water cooling removes the heat from the slit masks. The masks have been designed so that each one can be removed through a single vacuum port.

Specifications:

- Slit positional resolution:	10 μm
- Slit positional reproducibility:	25 μm
- Vertical aperture:	0 - 30 mm
- Horizontal aperture:	0 - 150 mm
- Vacuum tank flanges:	8 inch
- Vacuum tank length:	< 900 mm
- Actuator:	Standard APS light load stepping linear actuator
- Actuator drive:	Stepping motor with linear encoder
- Actuator maximum speed:	50 mm/min

ADVANCED PHOTON SOURCE

DRAFT

BM WHITE BEAM HORIZONTAL AND VERTICAL SLITS

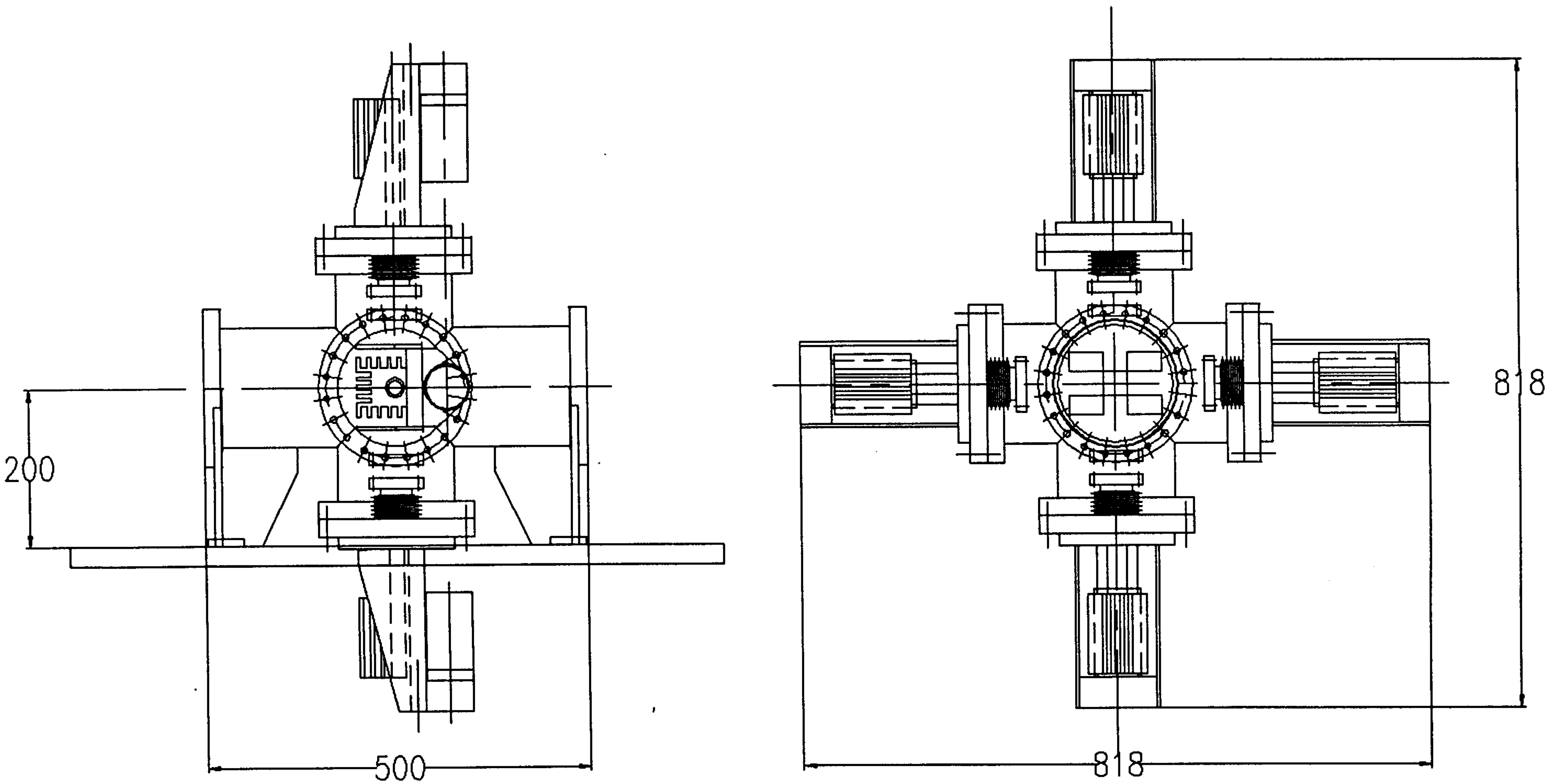


Figure 16

IDMONOS.DWG 01-20-92

ADVANCED PHOTON SOURCE DRAFT

ID MONOCHROMATIC BEAM HORIZONTAL AND VERTICAL SLITS

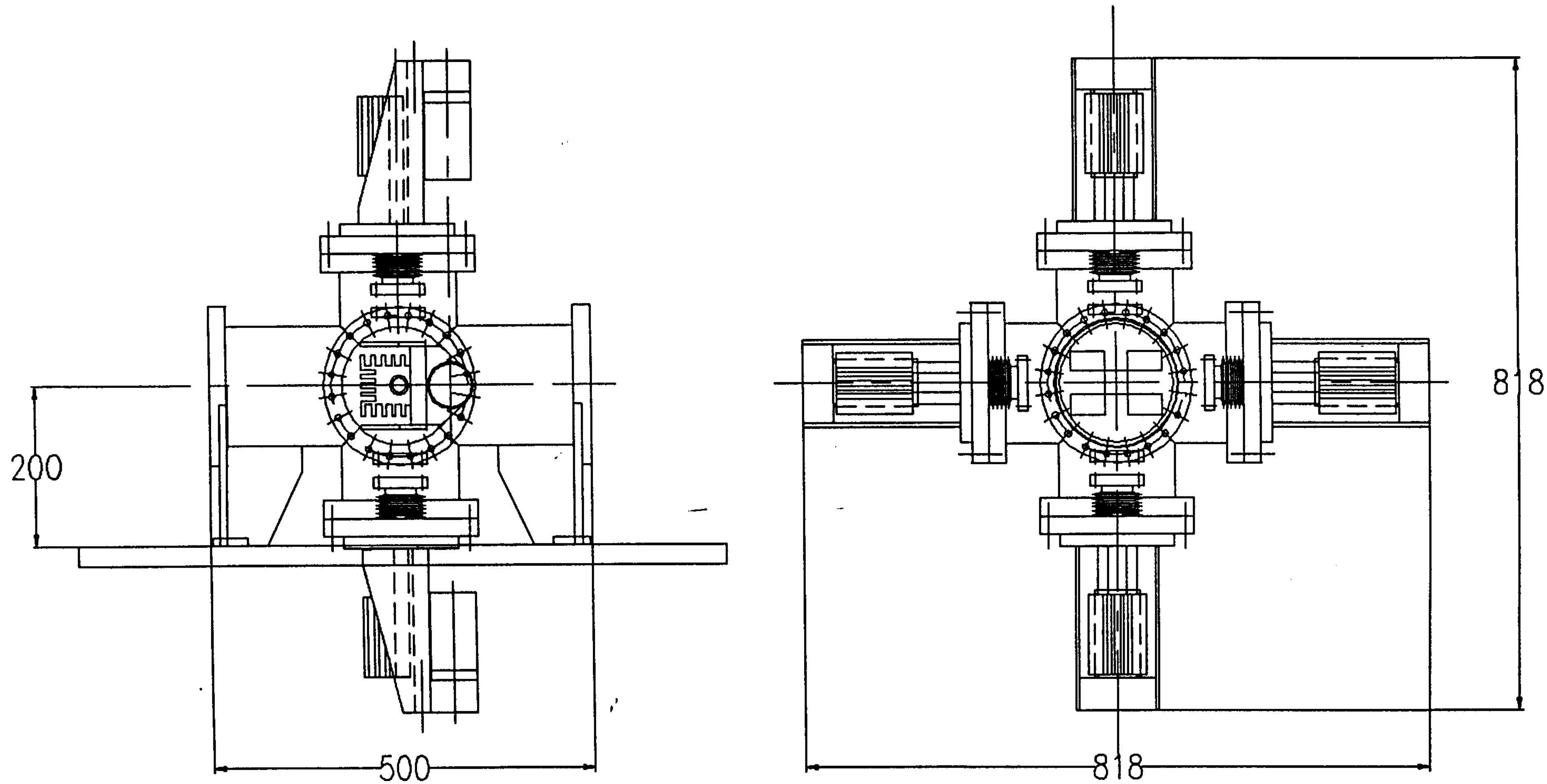


Figure 17 IDMONOS.DWG 01-20-92

6. Beam Shutters and Beam Stops

6.1. Monochromatic beam shutter - insertion device
6.2. White beam stop with integral shutter - insertion device
6.3. White beam stop with integral shutter - bending magnet (added later)

Design Considerations

All white beam stops discussed in sections 6.2 and 6.3 are combinations of water-cooled photon absorbers and heavy metal beam stops. Together photon absorber and beam stop completely stop all the radiation from any of the insertion device or bending magnet sources. In order to have a safe operationing scheme, the absorber and the stop will be locked with a "Kirk" key system parallel in its appropriate position.

Design Schedule

The design of the prototype is in an advanced stage and will be completed by May 1993.

6.1 Monochromatic Beam Shutter - Insertion Device

The monochromatic beam shutter is designed to handle monochromatic beam loads from APS insertion devices. In this design, the heat is conducted by a copper rod to a conventional aircooled radiator.

Assumptions

All APS beamlines are required to have two independent beam shutters, each capable of stopping the beam, so that there is less exposure than permitted according DOE guidelines (0.25 mrem/h). The following assumptions are made in this design specification:

1.	Maximum energy transmitted	500 keV
2.	Maximum critical energy of the ID	32.6 keV
3.	Maximum total power	10 W
4.	Maximum bandpass at 500 keV	0.1%
5.	Expected radiation dose behind one shutter	0.25 mrem/h

These are extremely conservative assumptions for the design because the monochromators are unlikely to propagate full spectrum power in the higher harmonics.

Specifications

1.	Material of the shutter	1/2" Cu + 1 5/8" (40 mm) heavy metal
2.	Optical aperture	80 x 40 mm^2
3.	Actuator	APS light load actuator with pneumatic drive (12.4)
4.	Closing time	1 sec
5.	Mounting flange	8" O.D.
6.	Vacuum	UHV compatible

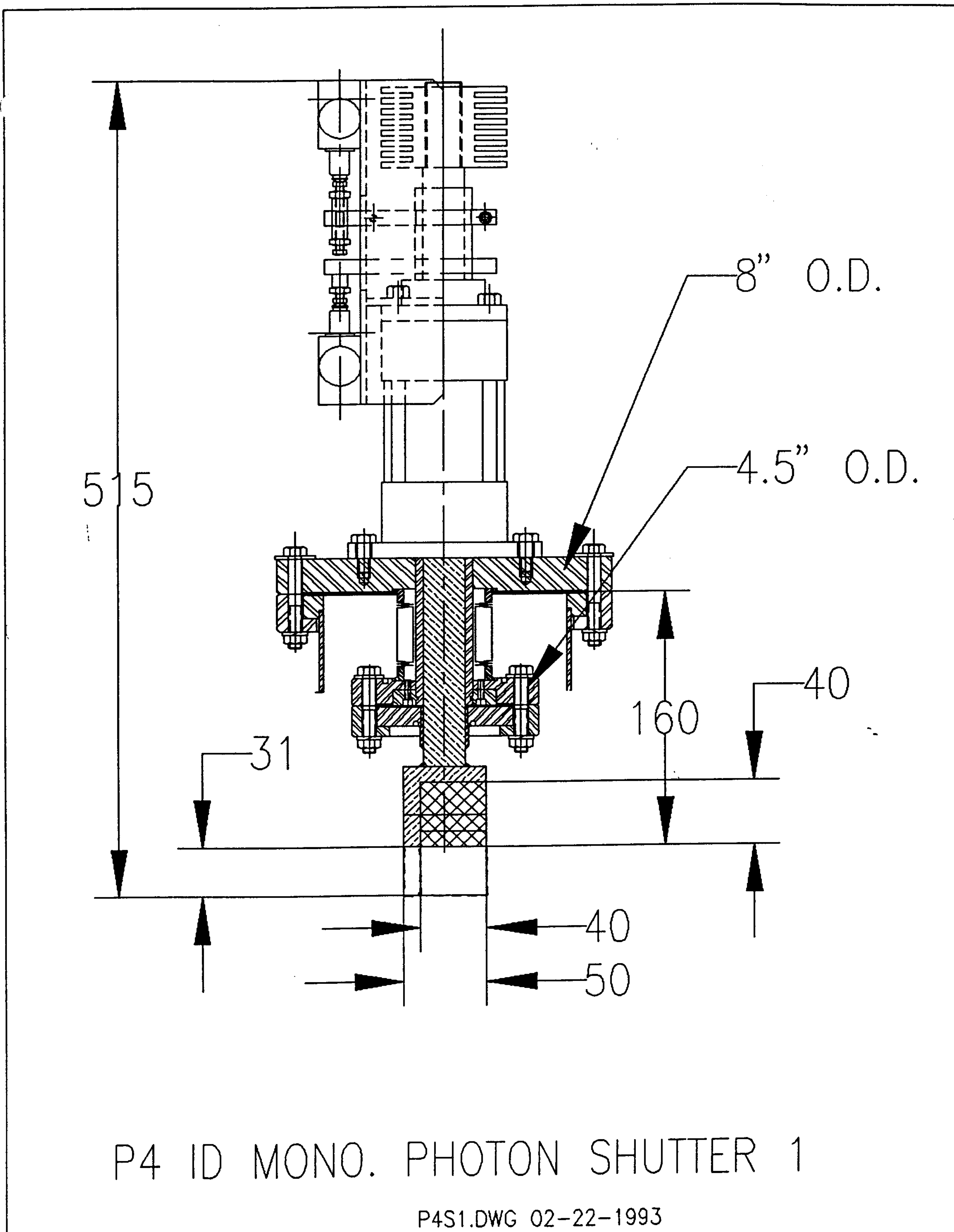

8" O.D.
4.5" O.D.
515
160
40
31
40
50
P4 ID MONO. PHOTON SHUTTER 1
P4S1.DWG 02-22-1993

Figure 18

ADVANCED PHOTON SOURCE

Design Specifications
for P4 ID White Beam Photon Absorber

1, Location : 31.10 m from APS ID Straight Section Center

2, Optical Aperture Area : 75 mm (H) x 13 mm (V)

3, Horizontal Maximum Acceptance : 2.57 mrad

4, Vertical Maximum Acceptance : 0.42 mrad

5, Closing Time : 1 sec

6, Input Frange O.D. : 8 inch

7, Output Frange O.D. : 14 inch

8, Mask Grazing Incidence Angle : 3 degree

9, Mask Material : OFHC with Glid-Cop Face Plate

10, Water Cooling : Mesh-filled Tube

11, Mask Motion Structure : Two-Point Suspension Hockey Stick

12, Actuator : Pneumatic

End Point Reproducibility : 10 um

13, Damper : Pneumatic

14, Mask Length : 250 mm

15, Device Frange to Frange Length : 1030 mm (with heavy metal stop)

16, Vacuum : UHV Compatible

17, Maximum Total Power : 5000 W

CATW0293.DOC 02-22-1993

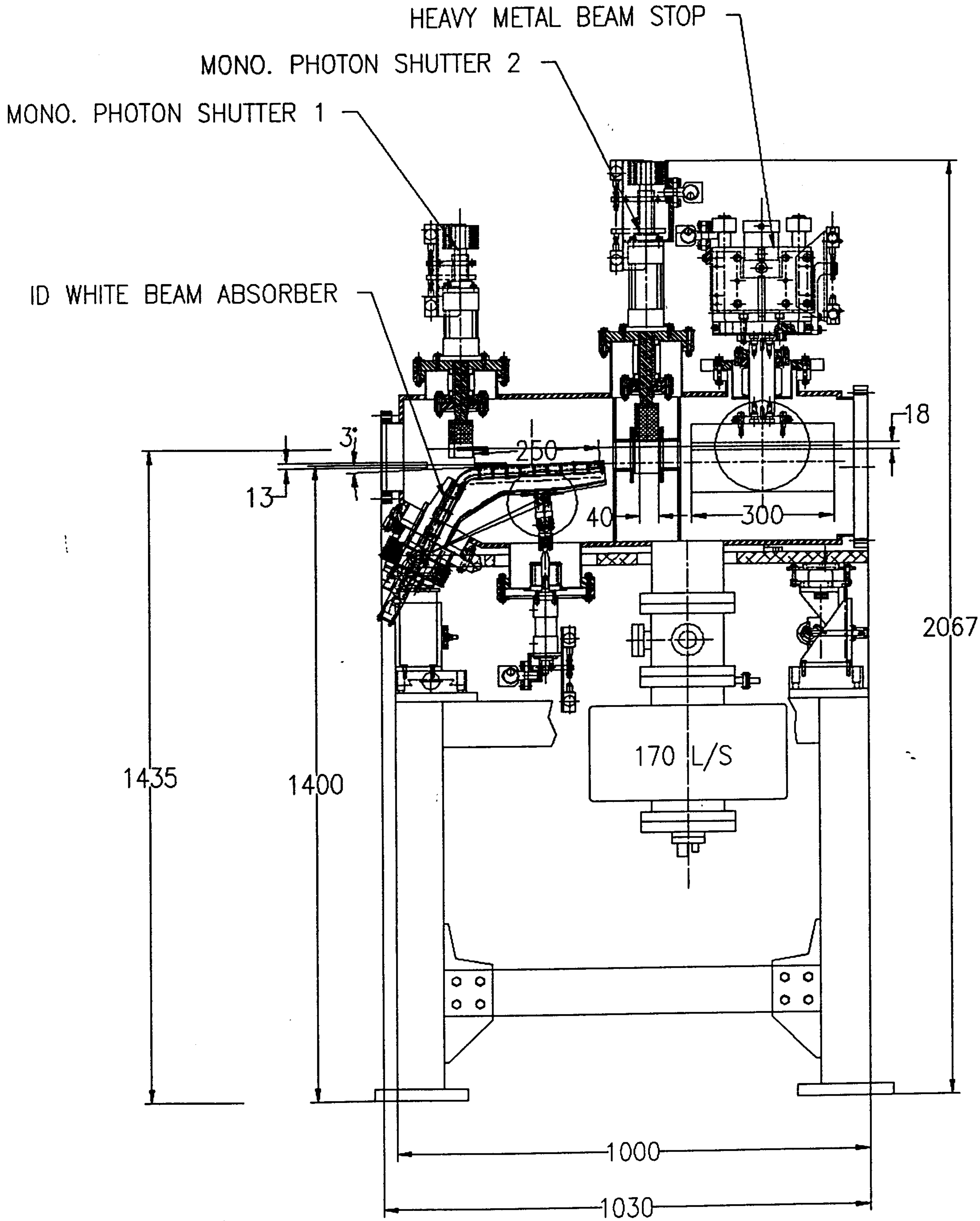


Figure 19

P4 INTEGRAL SHUTTERS & STOPS P4S1.DWG 02-22-1993

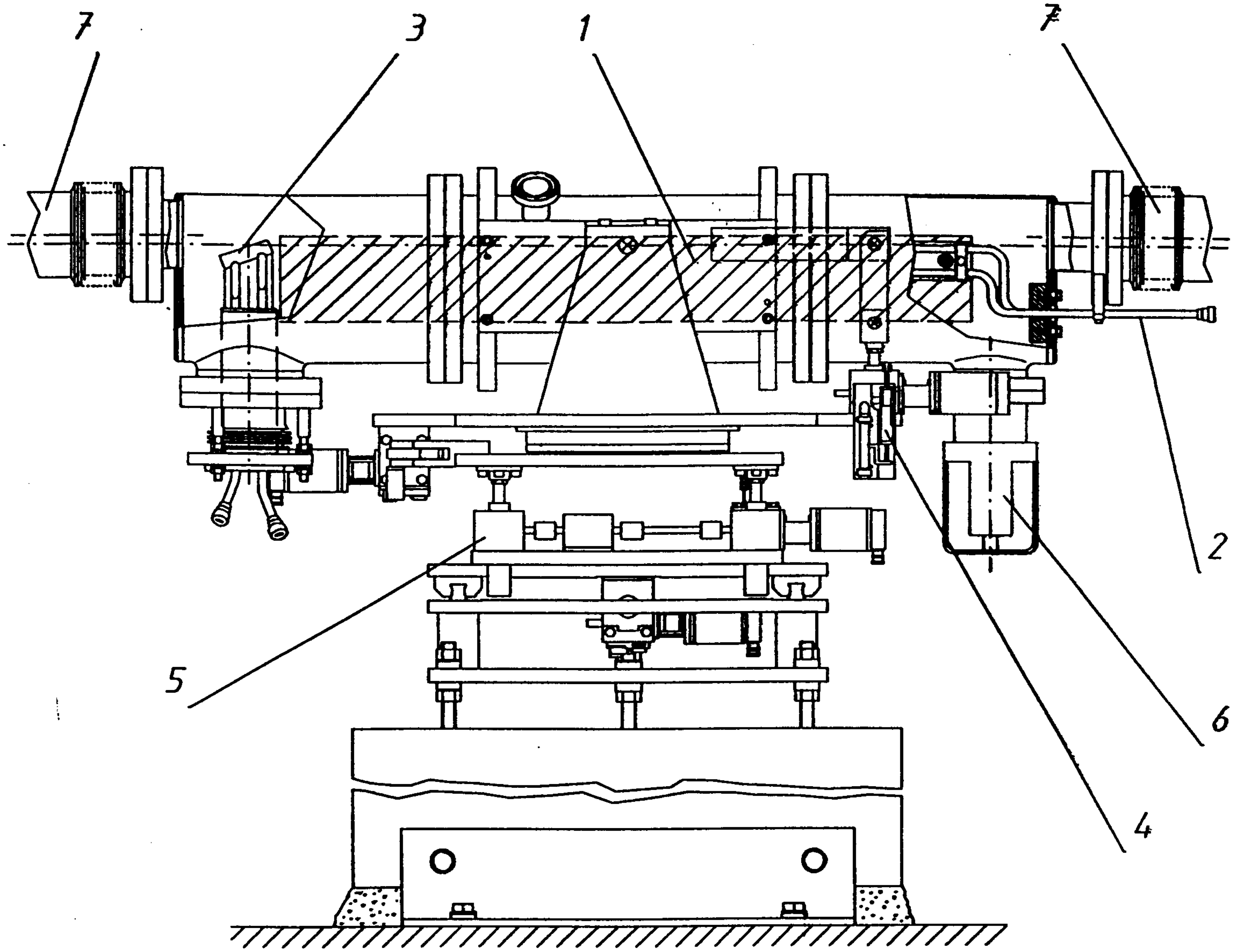
7. Mirror Chambers

Mirror chambers are used to provide a stable, vibration- and force-free support of beam deflecting mirrors. The chamber must allow the very precise alignment of the mirror. Angle resolutions of the deflection angle of less than 1 µrad have to be achieved. The vacuum condition in the chamber ($<1x10^{-9}$ torr) shall avoid carbon contamination of the reflecting surface. In combination with high power beamlines effective cooling has to be supplied. The chamber has to allow bending of the mirror for variable focusing.

To shift the photon energy cut off of the mirrors to high energies, very small reflection angles (e.g. 3 - 4 mrad) are needed. To get a sufficient beam acceptance of the mirror, long mirrors (> 1 m) are used. This strongly influences the chamber design. HASYLAB has had good experience with a chamber design, that makes use of a stiff central chamber frame. The mirror is supported by this frame. The stiffness of the frame withstands easy deformations introduced to the chamber by air pressure or thermal expansion without affecting the alignment of the mirror. The deformations are mainly carried by the cylindrical part of the chamber.

The mirror is aligned by aligning the whole chamber. The chamber movements are decoupled from the beamline by bellows, which allow transversal movements in the vertical and horizontal directions of ± 25 mm. Angular rotations around the beam axis have to be excluded to protect the bellows. This rotation can be easily excluded because of the very small deflection angle.

Figure 21 shows the cooled x - ray mirror chamber design for a 1-m-long cooled toroidal mirror at HASYLAB. Because these are well-tested designs, the APS plans to adopt these designs for the use of the CATs. An improved design drawing for such a mirror chamber will be available before September 1993. The support system for the mirror chamber is also a standard design and is discussed in section 9.1.3.



X - ray mirror chamber for high power beamlines at HASYLAB

Design criteria:

- mirror alignment by moving the whole mirror chamber
- linear and rotational movings mechanically decoupled
- rigid central chamber frame as mirror support
- friction-free rotation of the deflection angle (resolution < 1μrad)
- chamber movement decoupled from the beamline by formed bellows
  range of linear movement ± 25 mm

1 toroidal mirror (1000 x 130 x 130)
2 water cooling
3 water-cooled absorber (protection of the mirror face)
4 linear encoder
5 mirror support and aligning system
6 ion pump
7 bellows

Figure 20

8. Beam position monitors

8.1. White beam position monitor
8.2. Monochromatic beam position monitor

Design Schedule

A prototype of the white beam position monitor for the ID beams has been built and tested. The drawings are in section 8.1, along with specifications.

The monochromatic beam position monitors are of a lower priority for design, because many designs are already in use at various synchrotron facilities.

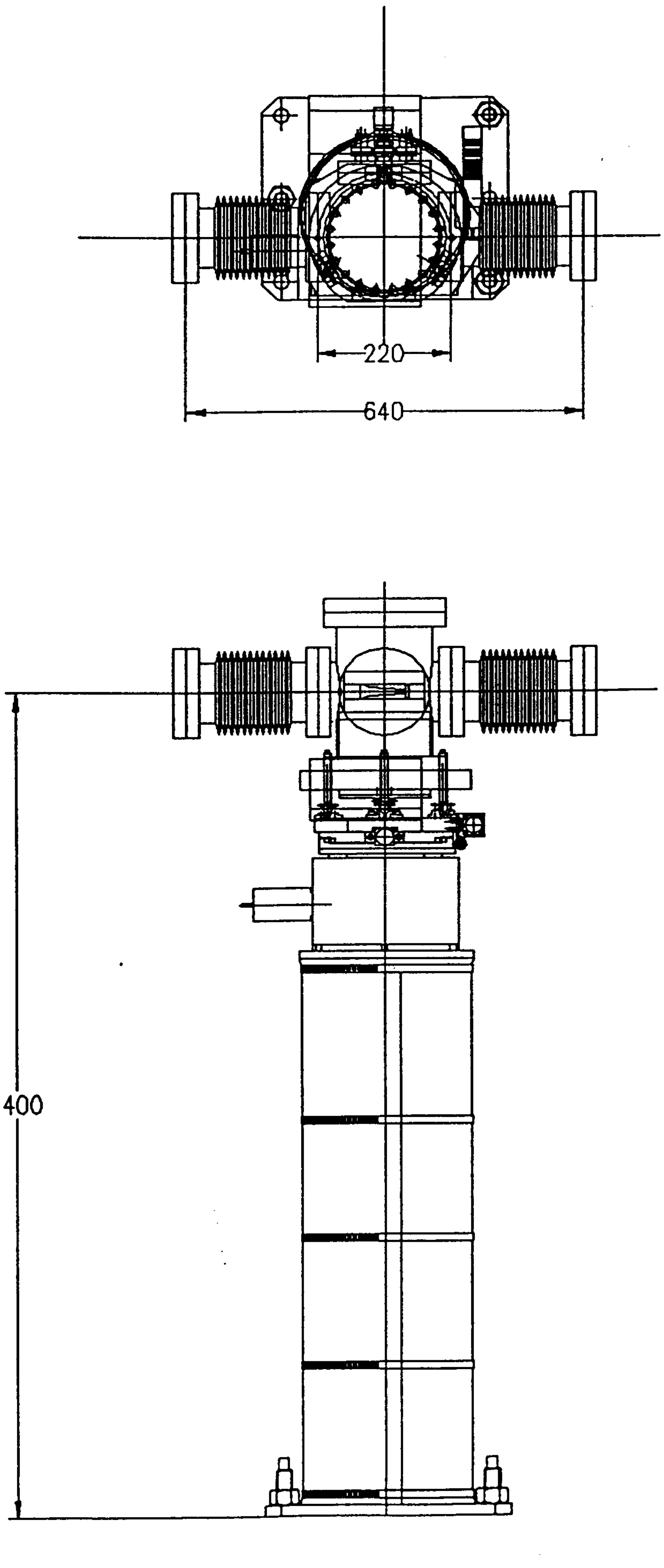
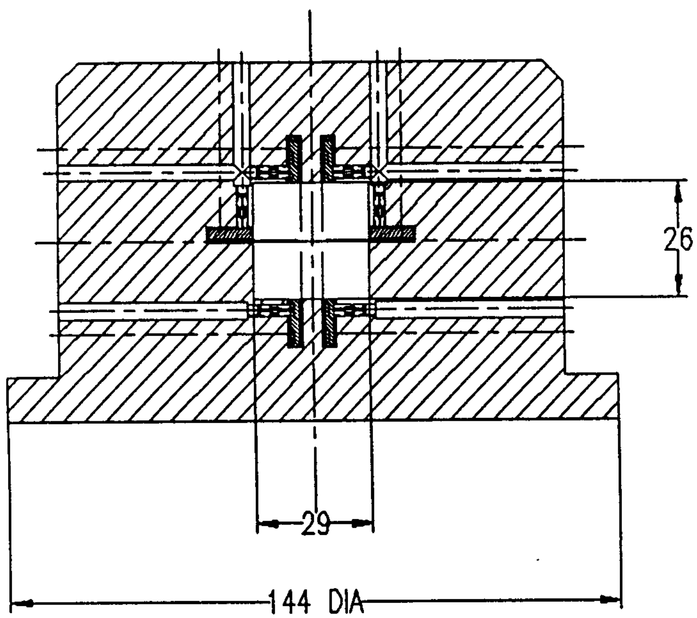
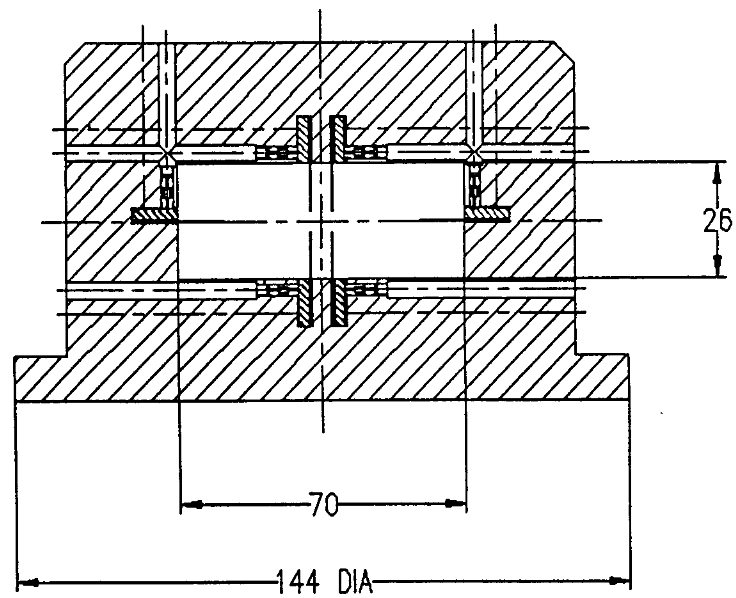


Figure 21

ID FE PBPM
(FIXED VERSION)



ID FE PBPM
(FOR UNDULATOR A)



ID FE PBPM
(FOR WIGGLER A)

Figure 22

9. Supports

9.1. Kinematic mount support tables
9.1.1. Economic style support table
9.1.1.1. Vertical motion cone
9.1.1.2. Vertical motion V
9.1.1.3. Vertical motion Flat
9.1.1.4. Horizontal motion
9.1.2. Standard style support table
9.1.2.1. Standard vertical stage
9.1.2.2. Standard horizontal stages
9.1.2.3. Standard spherical soupling
9.1.2.4. Standard V coupling
9.1.2.5. Standard Flat coupling
9.1.3. Precision style support table
9.1.3.1. Precision vertical stage - "A"
9.1.3.2. Precision vertical stage - "B"
9.1.3.3. Precision vertical stage - "C"
9.1.3.4. Precision horizontal stage - "A"
9.1.3.5. Precision horizontal stage - "B"
9.1.3.6. Precision horizontal stage - "C"
9.2. Beam position monitor support
9.2.1. Beam position monitor vertical stage
9.2.2. Beam position monitor horizontal stage
9.2.3. Beam position monitor rotation stage
9.2.4. Beam position monitor support column
9.2.5. Beam position monitor kinematic mount cone
9.2.6. Beam position monitor kinematic mount flat
9.2.7. Beam position monitor kinematic mount V
9.3. Ion pump supports
9.3.1. Inline 60 l/s ion pump support
9.4. Beam pipe supports
9.4.1. 6" beam pipe support

<u>Design Status</u>

All supports have been fully designed. The prototypes of each of the supports are either already built or under construction. The tests will be completed by June 1993.

APS/XFD FE Support System

	FE Economic Support Table	FE Standard Support Table	FE Precision Support Table	FE PBPM Support
Max. Load (Kg)	1000	1000	1000	90
Slide Type (V)	N/A	Linear Rolling	Linear Rolling	Linear Rolling
Slide Type (H)	Regular Friction	Regular Friction	Linear Rolling	Linear Rolling
Travel Range (V) (H) (mm)	50	50	12.7	12.7
Motion (V) Resolution (um)	250	50	10	0.1
Motion (H) Resolution (um)	250	50	10	0.1
Motion (V) Repeatability (um)	400	100	50	2
Motion (H) Repeatability (um)	400	250	50	2
(V) Straightness of Trajectory (rad/5mm)	N/A	5 E -4	2 E -4	1 E -5
(H) Straightness of Trajectory (rad/5mm)	N/A	2 E -3	1 E -4	1 E -5
Basic Operating Mode	Manual	Manual	Stepping Motor	Stepping Motor
Optional Operating Mode	N/A	Stepping Motor	Manual	Manual

ADVANCED PHOTON SOURCE

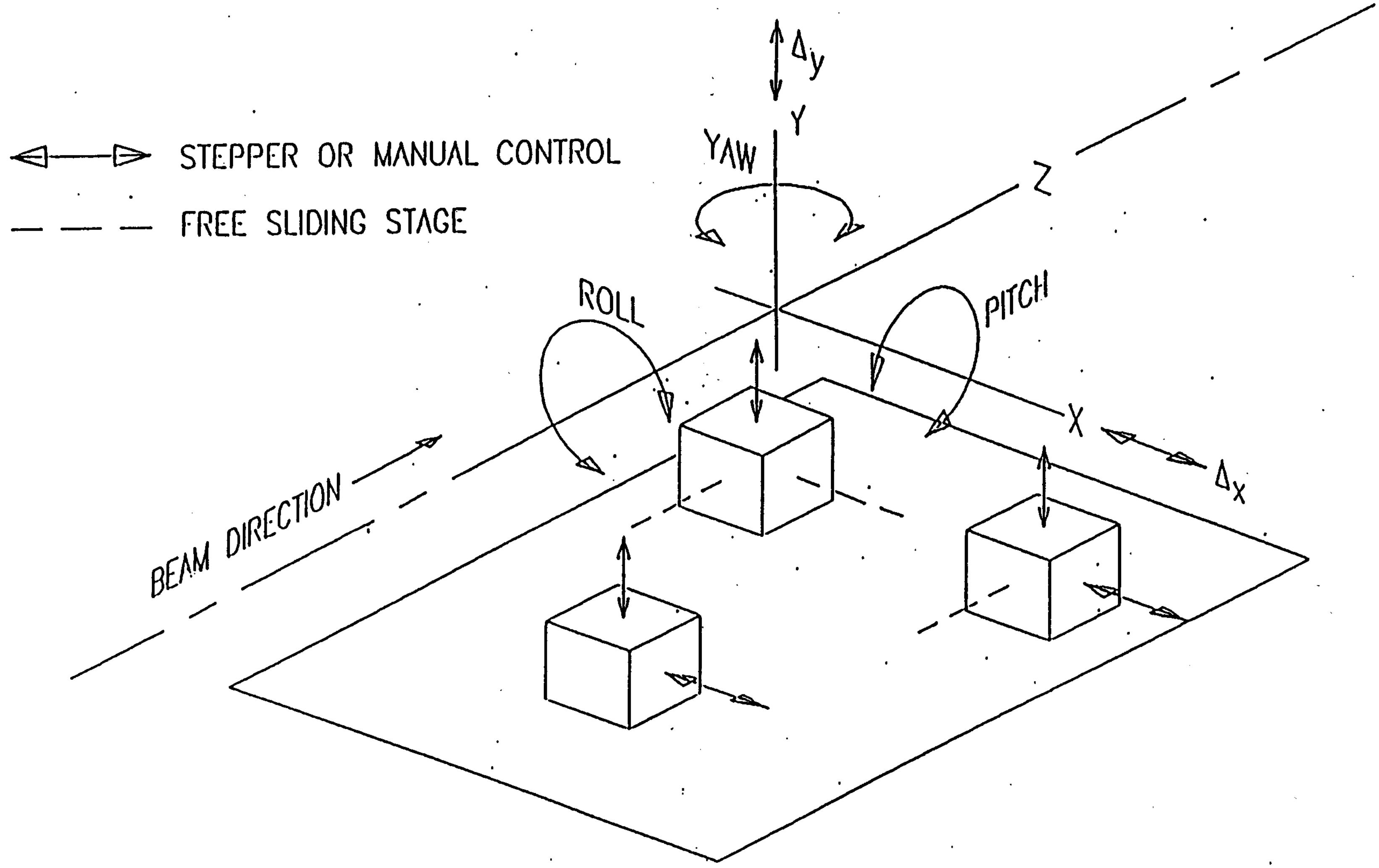


Figure 23 3-POINT KINEMATIC MOUNTING

ECONOMICAL SUPPORT TABLE SPECIFICATIONS

Max. Load (Kg)	1000
Slide Type (V)	N/A
Slide Type (H)	Regular Friction
Travel Range (V) (H) (mm)	50
Motion (V) Resolution (um)	250
Motion (H) Resolution (um)	250
Motion (V) Repeatability (um)	400
Motion (H) Repeatability (um)	400
(V) Straightness of Trajectory (rad/5mm)	N/A
(H) Straightness of Trajectory (rad/5mm)	N/A
Basic Operating Mode	Manual
Optional Operating Mode	N/A

ADVANCED PHOTON SOURCE

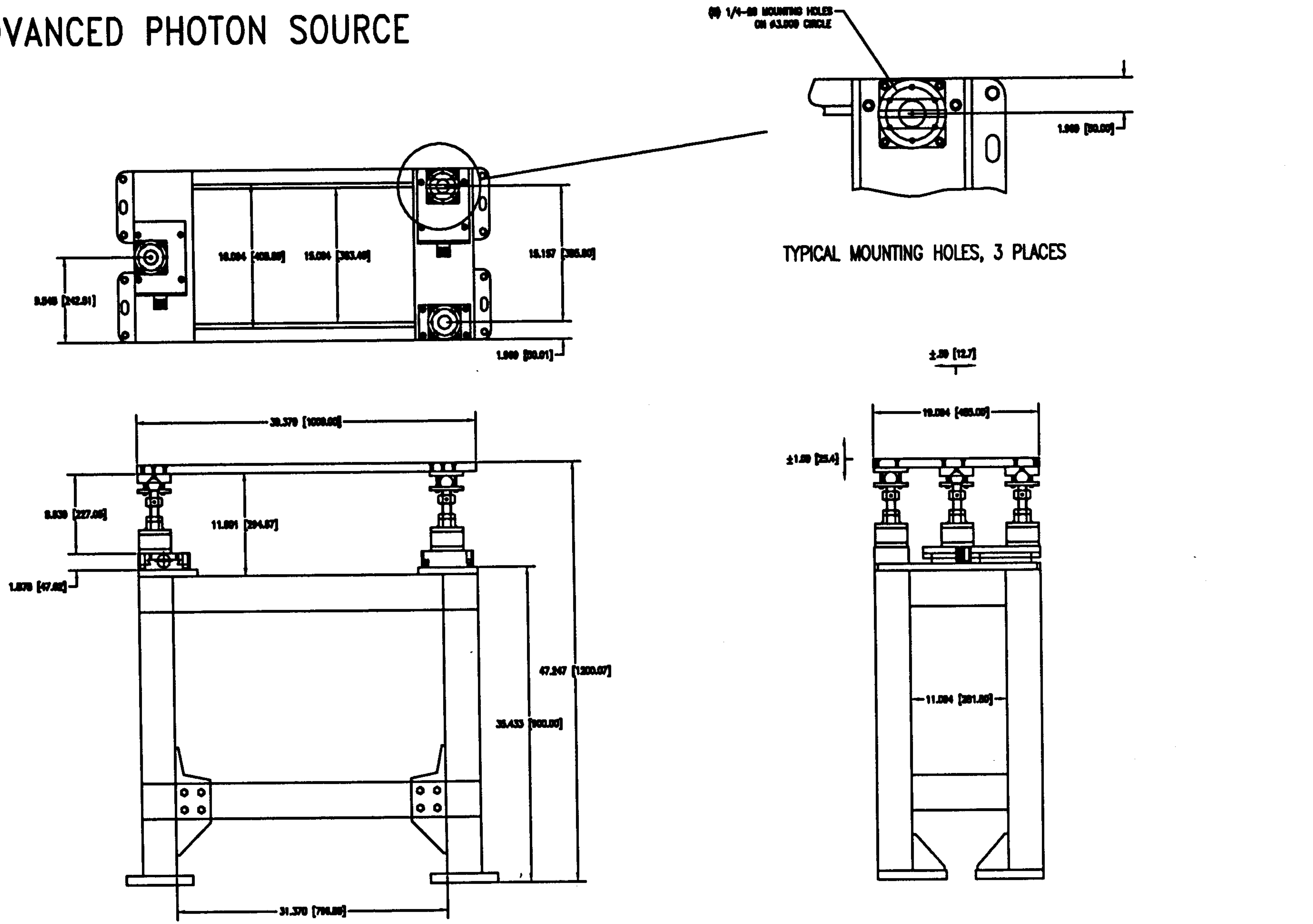


Figure 24

ECONOMICAL SUPPORT BASE WITH ECONOMICAL STYLE KINEMATIC MOUNT STAGES

ADVANCED PHOTON SOURCE

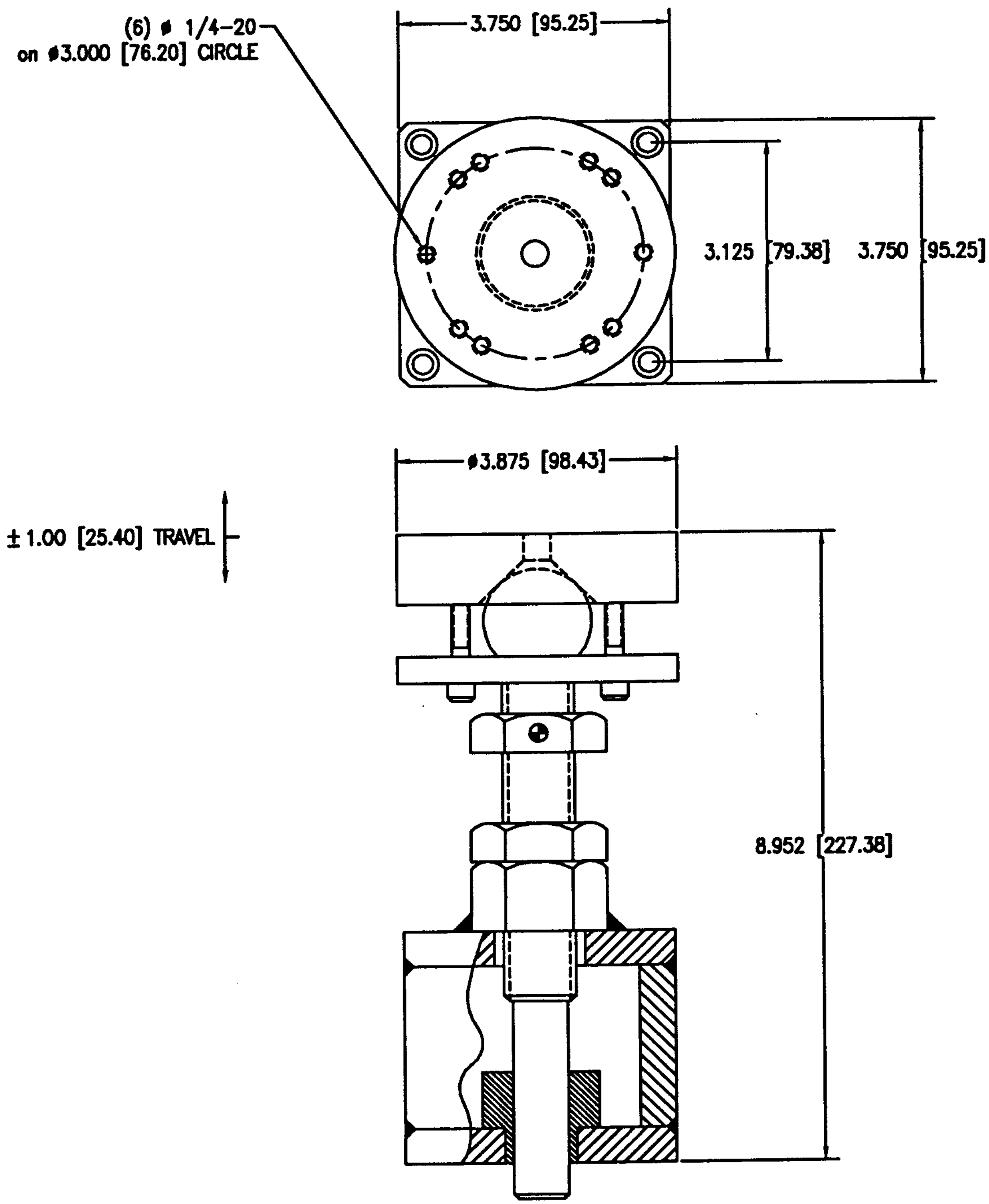


Figure 25

ECONOMICAL VERTICAL KINEMATIC MOUNT – CONE

ADVANCED PHOTON SOURCE

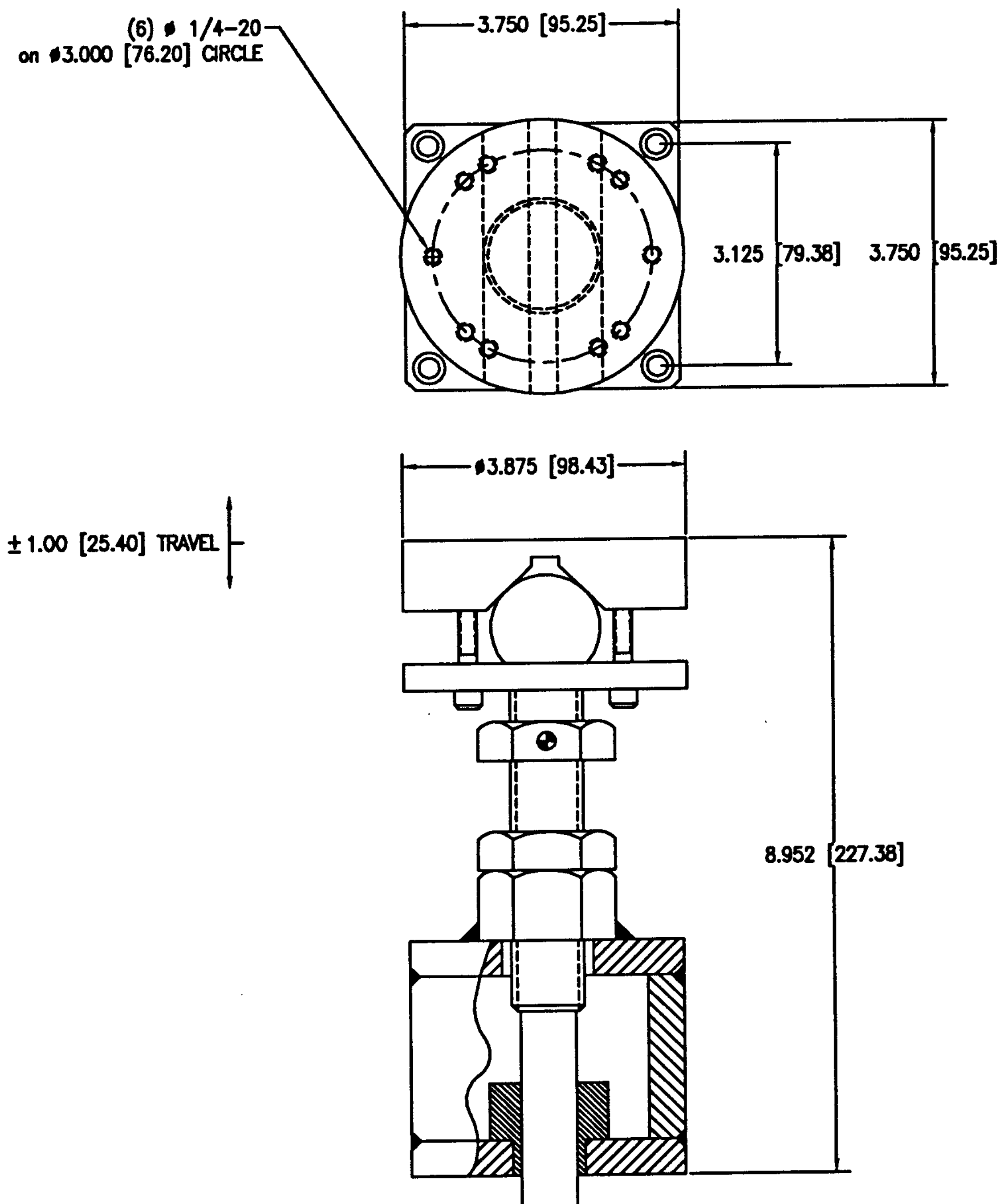


Figure 26

ECONOMICAL VERTICAL KINEMATIC MOUNT – V

ADVANCED PHOTON SOURCE

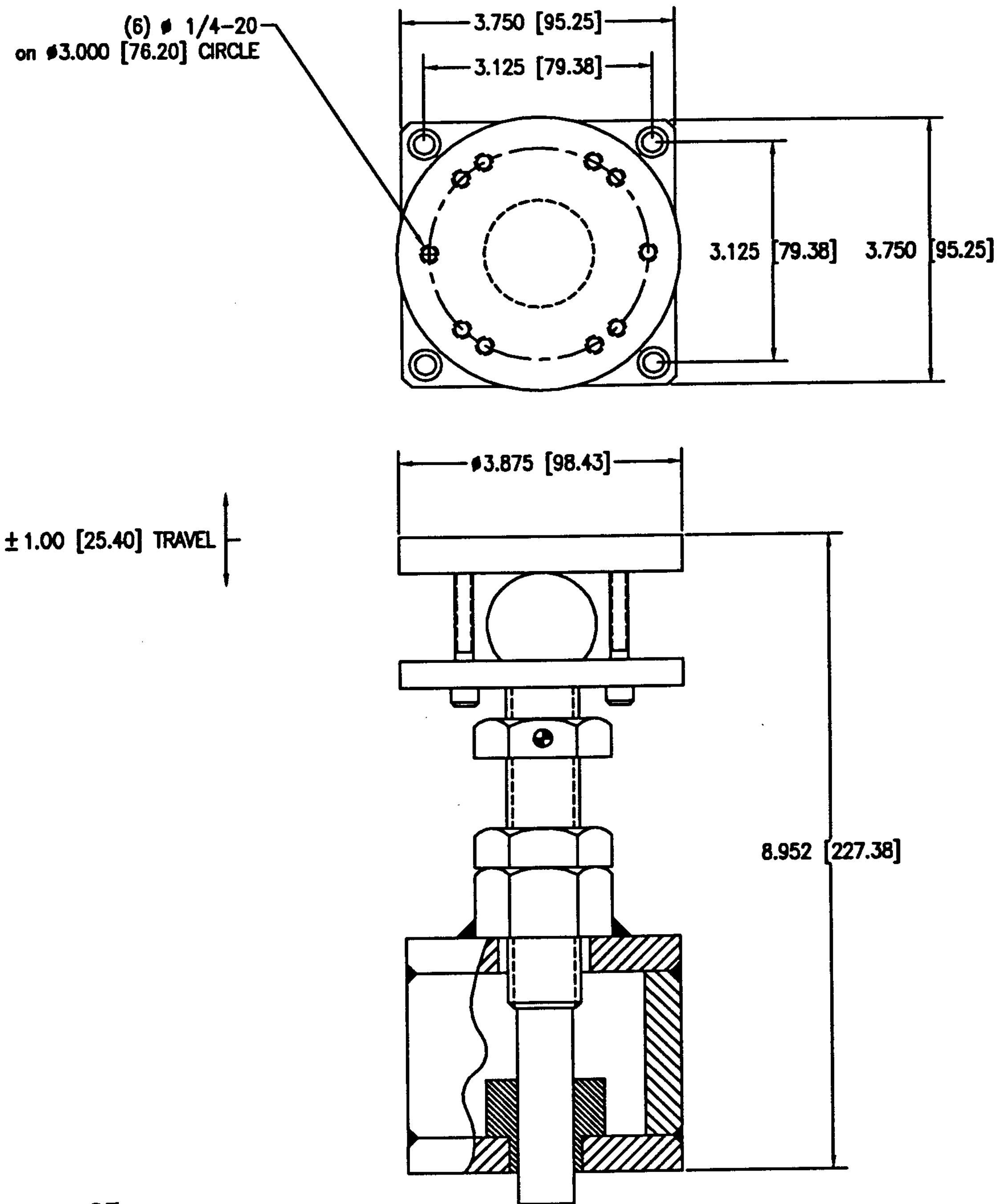


Figure 27

ECONOMICAL VERTICAL KINEMATIC MOUNT – FLAT

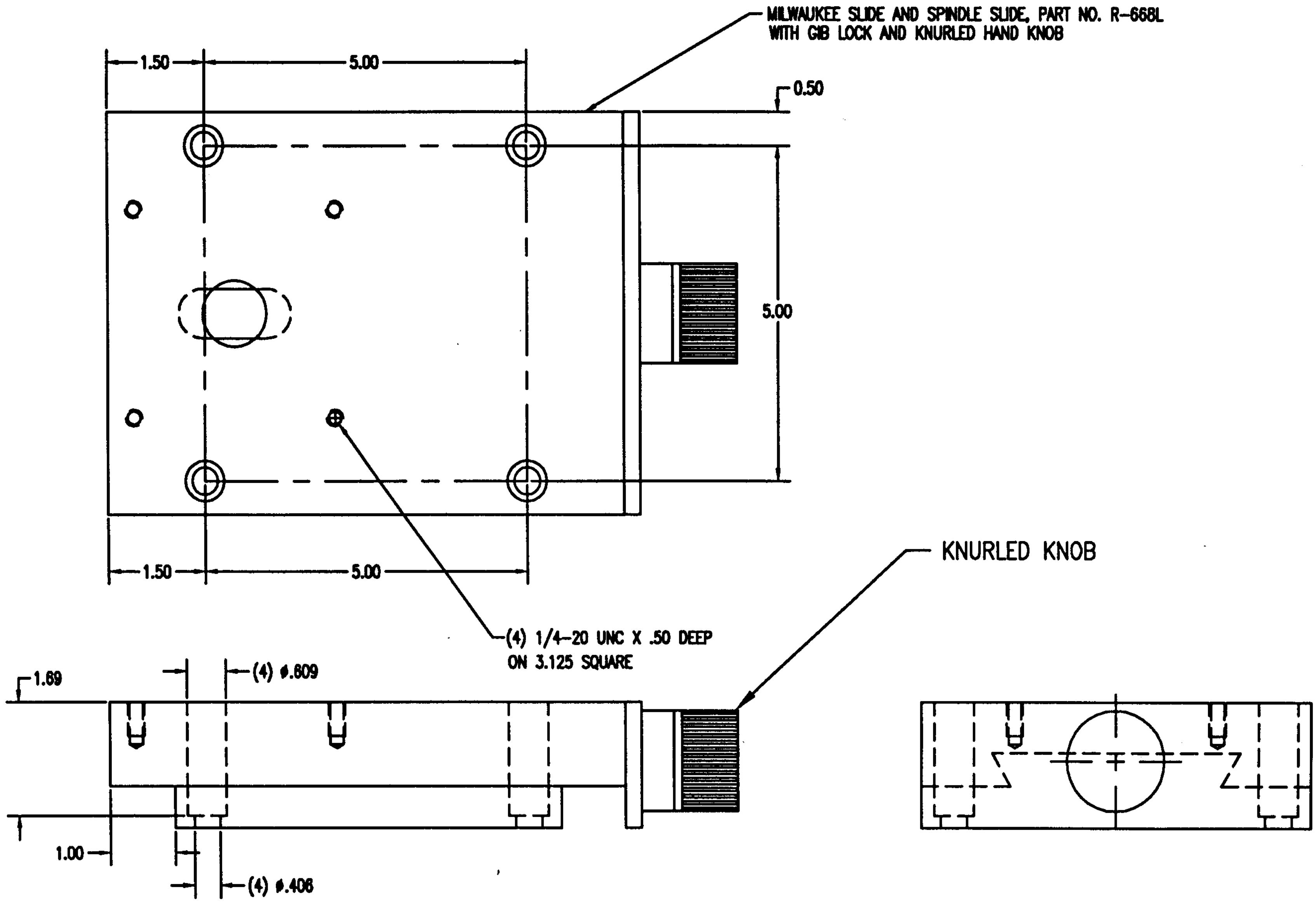
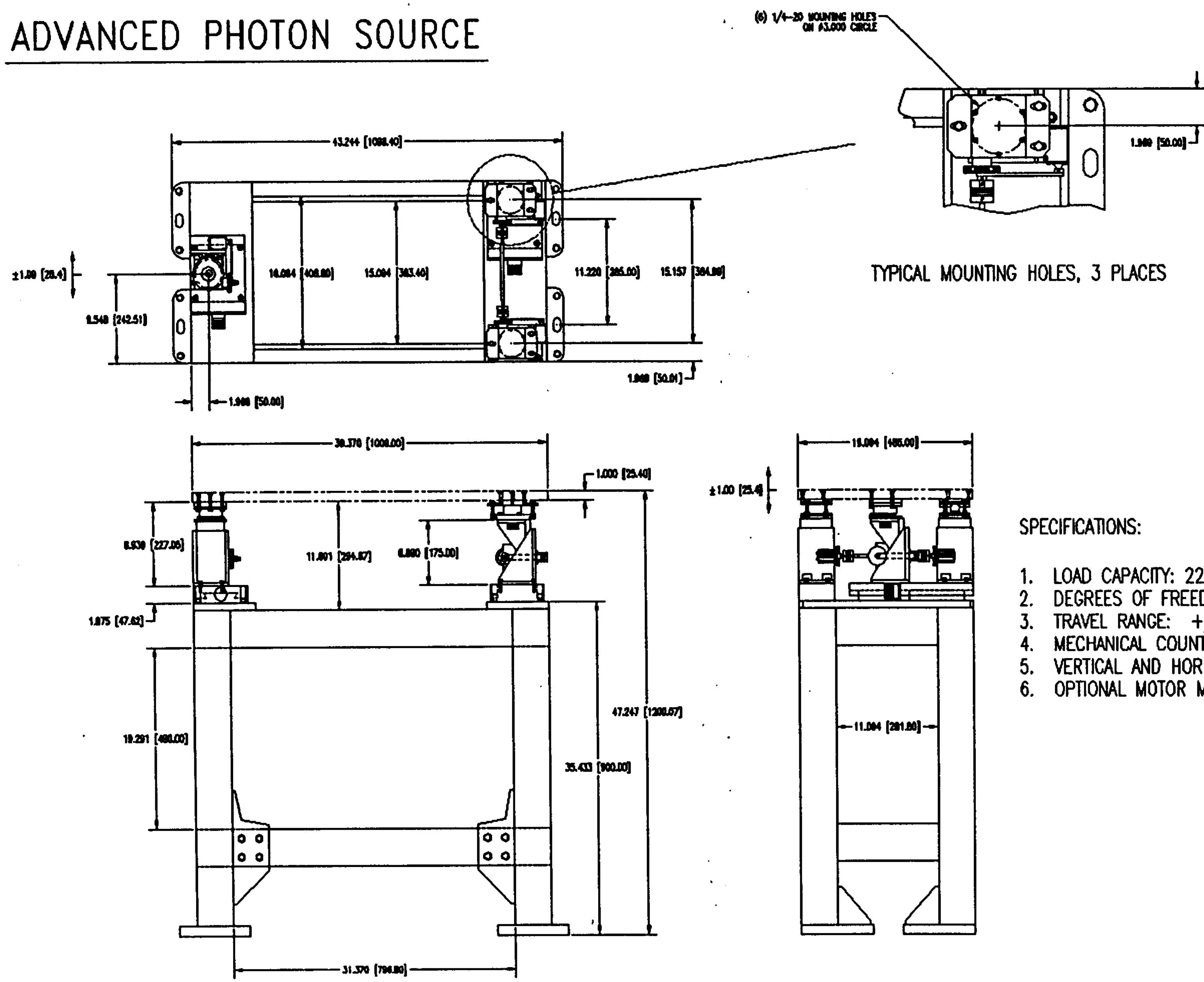


Figure 28 ECONOMICAL KINEMATIC MOUNT HORIZONTAL SLIDE

STANDARD SUPPORT TABLE SPECIFICATIONS

Max. Load (Kg)	1000
Slide Type (V)	Linear Rolling
Slide Type (H)	Regular Friction
Travel Range (V) (H) (mm)	50
Motion (V) Resolution (um)	50
Motion (H) Resolution (um)	50
Motion (V) Repeatability (um)	100
Motion (H) Repeatability (um)	250
(V) Straightness of Trajectory (rad/5mm)	5 E -4
(H) Straightness of Trajectory (rad/5mm)	2 E -3
Basic Operating Mode	Manual
Optional Operating Mode	Stepping Motor

ADVANCED PHOTON SOURCE



SPECIFICATIONS:

1. LOAD CAPACITY: 2200 LBS [1000 kg]
2. DEGREES OF FREEDOM 5
3. TRAVEL RANGE: +/-1" [25.4 mm]
4. MECHANICAL COUNTER RESOLUTION: .005"/COUNT
5. VERTICAL AND HORIZONTAL ADJUSTMENT: HAND KNOB
6. OPTIONAL MOTOR MOUNTS AVAILABLE

Figure 29 STANDARD SUPPORT BASE WITH STANDARD KINEMATIC MOUNT STAGES

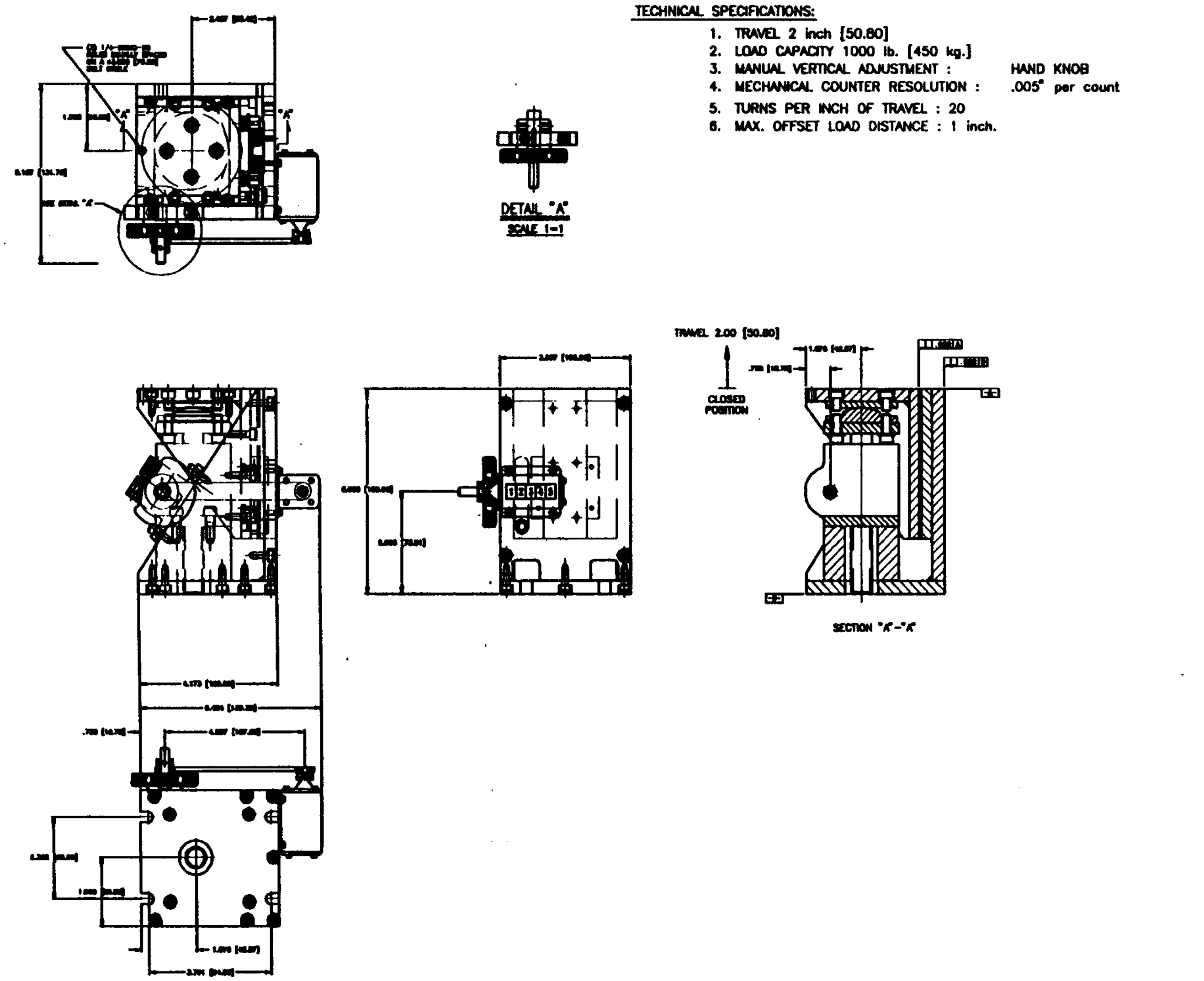


Figure 30 STANDARD KINEMATIC MOUNT VERTICAL STAGE

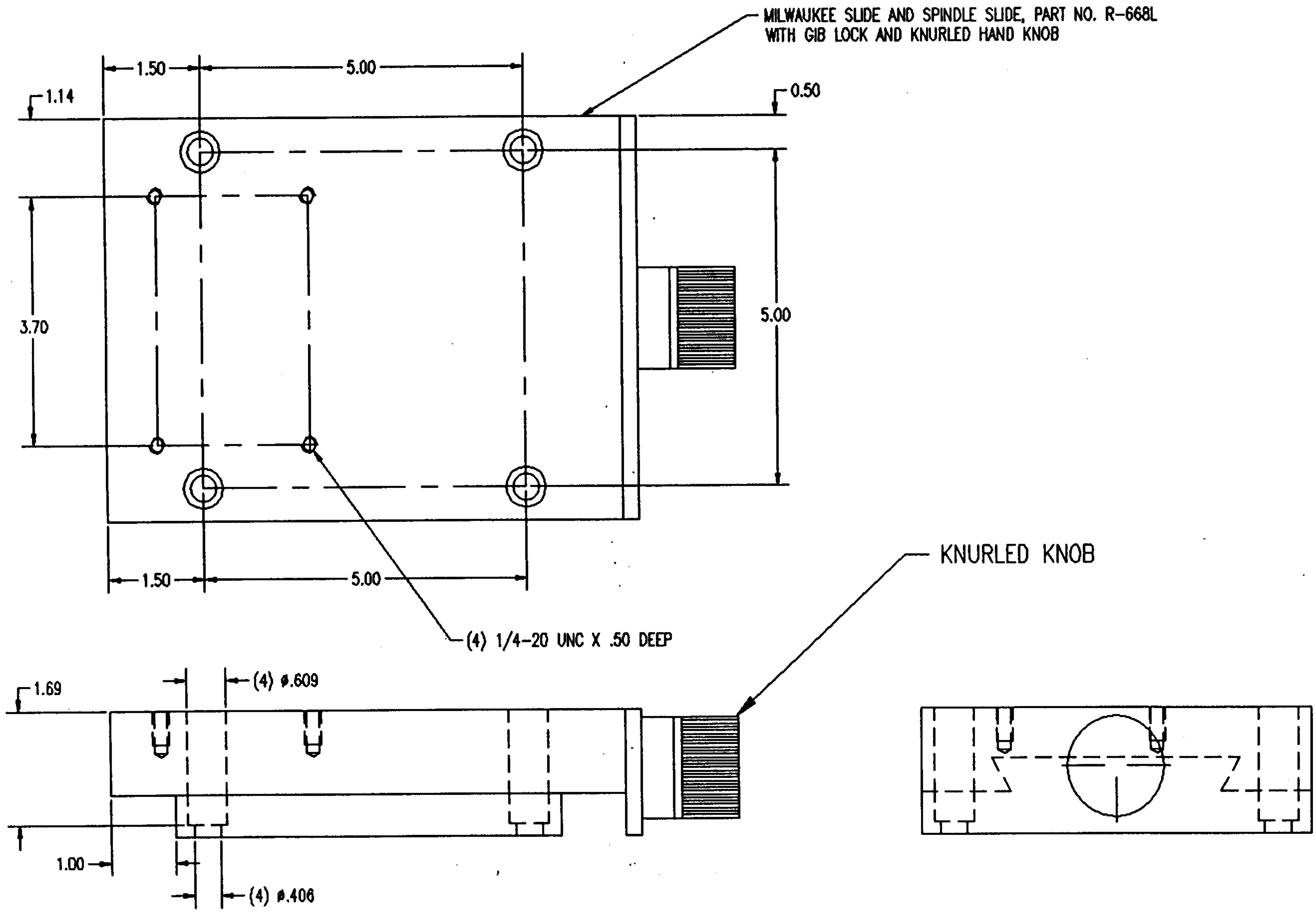
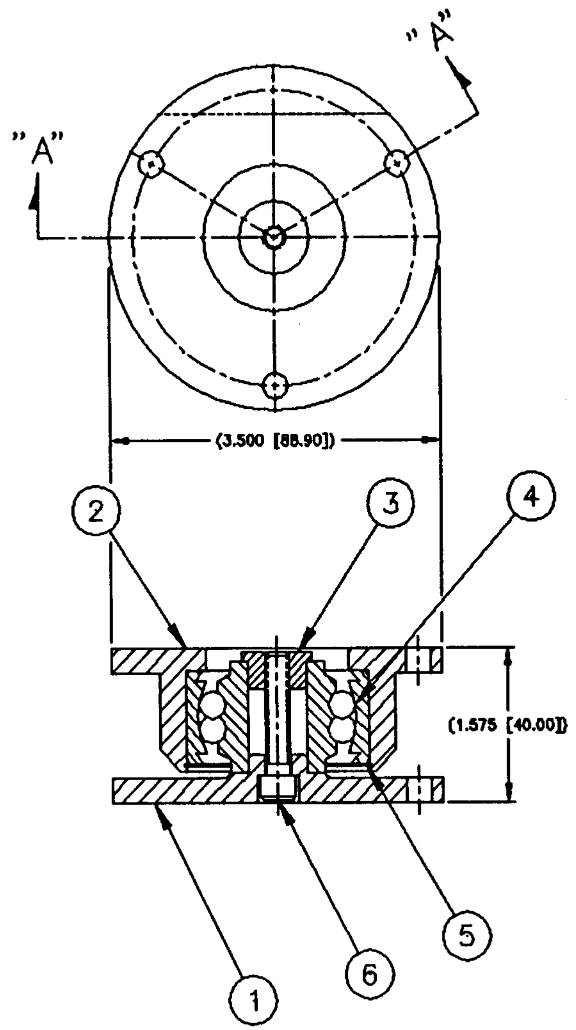


Figure 31 STANDARD KINEMATIC MOUNT HORIZONTAL STAGE



SECTION "A"–"A"

NOTE:

1. ALL DIMENSIONS SHOWN IN [] ARE MILLIMETERS.

ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
6		1/4–20UNC–2A X 1.25 LG. CAP. SCR.	STN. STL.	1
5		RETAINING RING, (ASSOC. SPRING)	CI 193	1
4		BEARING, SELF ALIGNING (AST)	DSP–10	1
3	P4105090501–820803	FASTENER	304 STN. STL. ROUND	1
2	P4105090501–820802	BEARING HOUSING	304 STN. STL. ROUND	1
1	P4105090501–820801	BASE	304 STN. STL. ROUND	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS .X ± .XX ±.01 [0.25] .XXX ±.005 [0.127] ANGULAR ±0°30'
SURFACE ROUGHNESS 125/
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: A07504

THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

DRAWN BY: HP Czerwinski — DATE: 6/22/92
CHECKED BY:
DESIGNER: J.BARRAZA, HP Czerwinski
RESPONSIBLE ENGINEER: J. BARRAZA
CHIEF DESIGN ENGINEER: D. SHU — DATE:
GP LEADER: T.KUZAY
PROJECT MGR.:
APPROVED/RELEASED:

TITLE: ADVANCED PHOTON SOURCE
T1 FRONT END
SPHERICAL COUPLING
ASSEMBLY

MATERIAL: SEE BILL OF MATERIAL
SCALE: 1:1 — SHEET 1 of 1 — SIZE: C — DRAWING NUMBER: P4105090501–820800–00

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS

STANDARD KINEMATIC MOUNT SPHERICAL COUPLING

Figure 32

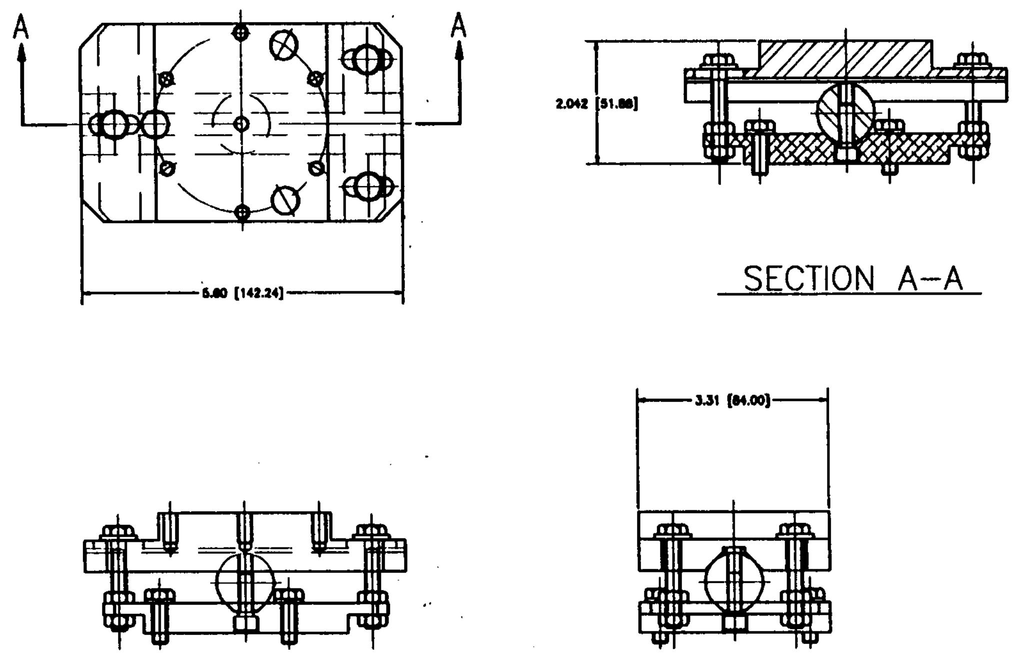


Figure 33 STANDARD KINEMATIC MOUNT V COUPLING

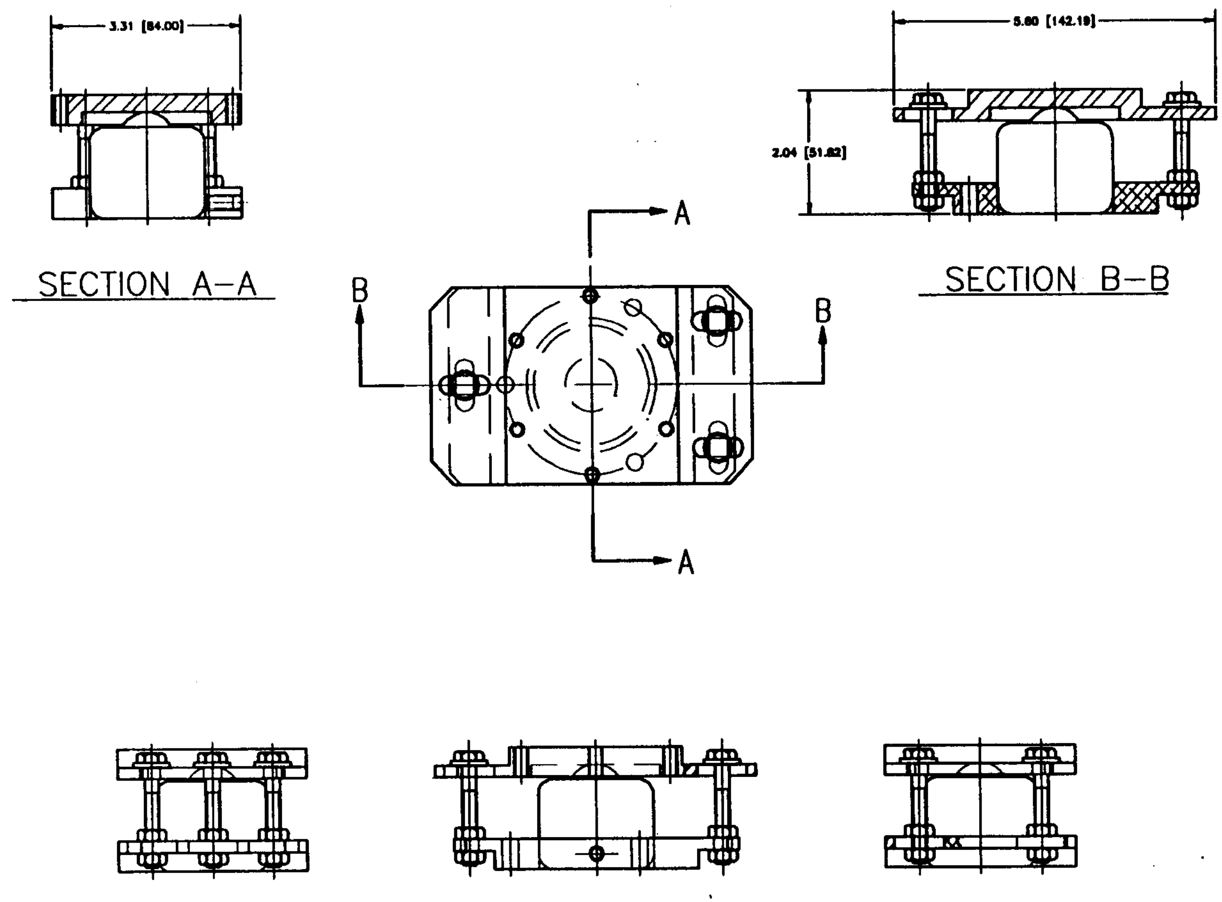


Figure 34 STANDARD KINEMATIC MOUNT FLAT COUPLING

PRECISION SUPPORT TABLE SPECIFICATIONS

Max. Load (Kg)	1000
Slide Type (V)	Linear Rolling
Slide Type (H)	Linear Rolling
Travel Range (V) (H) (mm)	12.7
Motion (V) Resolution (um)	10
Motion (H) Resolution (um)	10
Motion (V) Repeatability (um)	50
Motion (H) Repeatability (um)	50
(V) Straightness of Trajectory (rad/5mm)	2 E -4
(H) Straightness of Trajectory (rad/5mm)	1 E -4
Basic Operating Mode	Stepping Motor
Optional Operating Mode	Manual

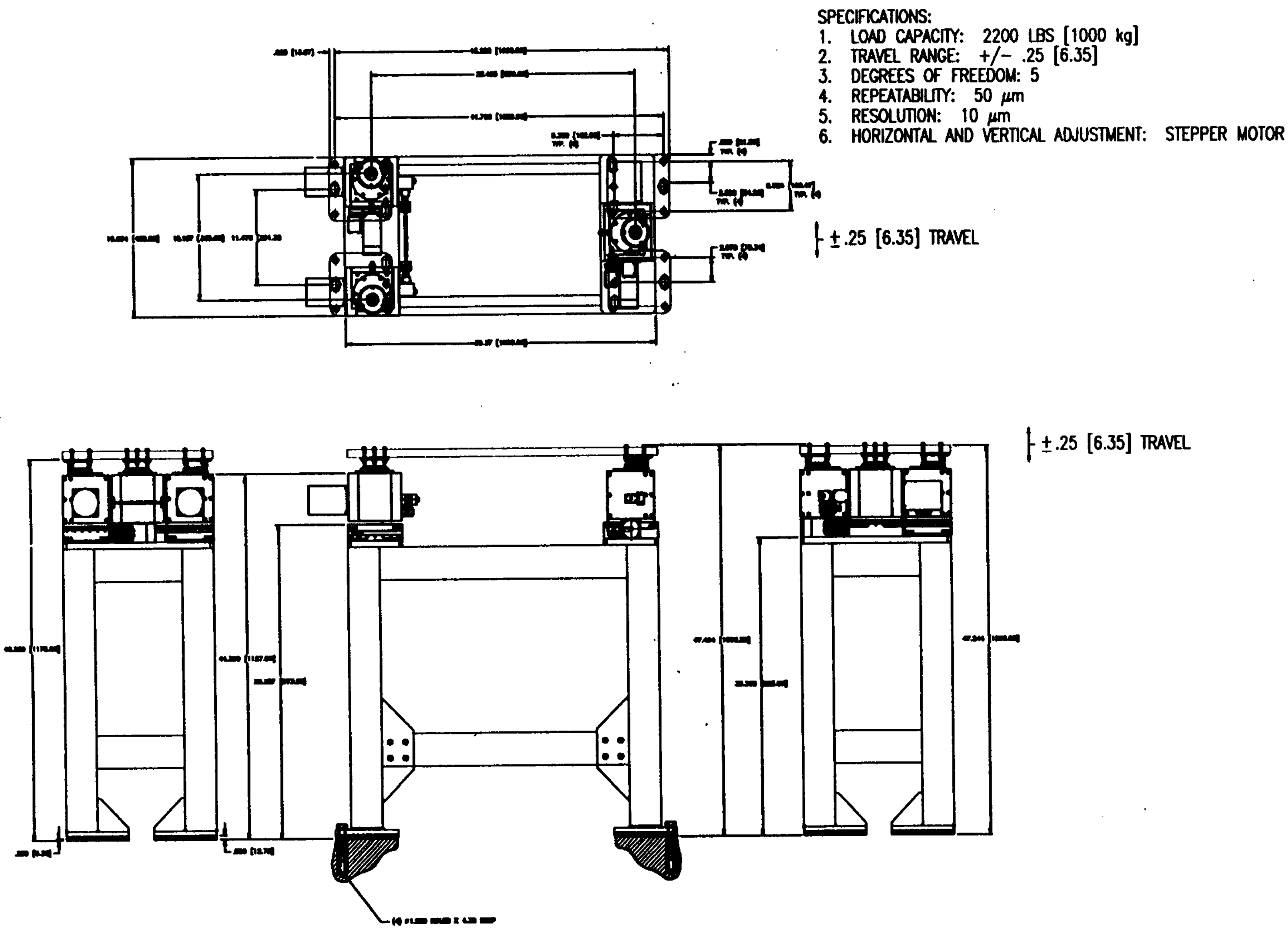
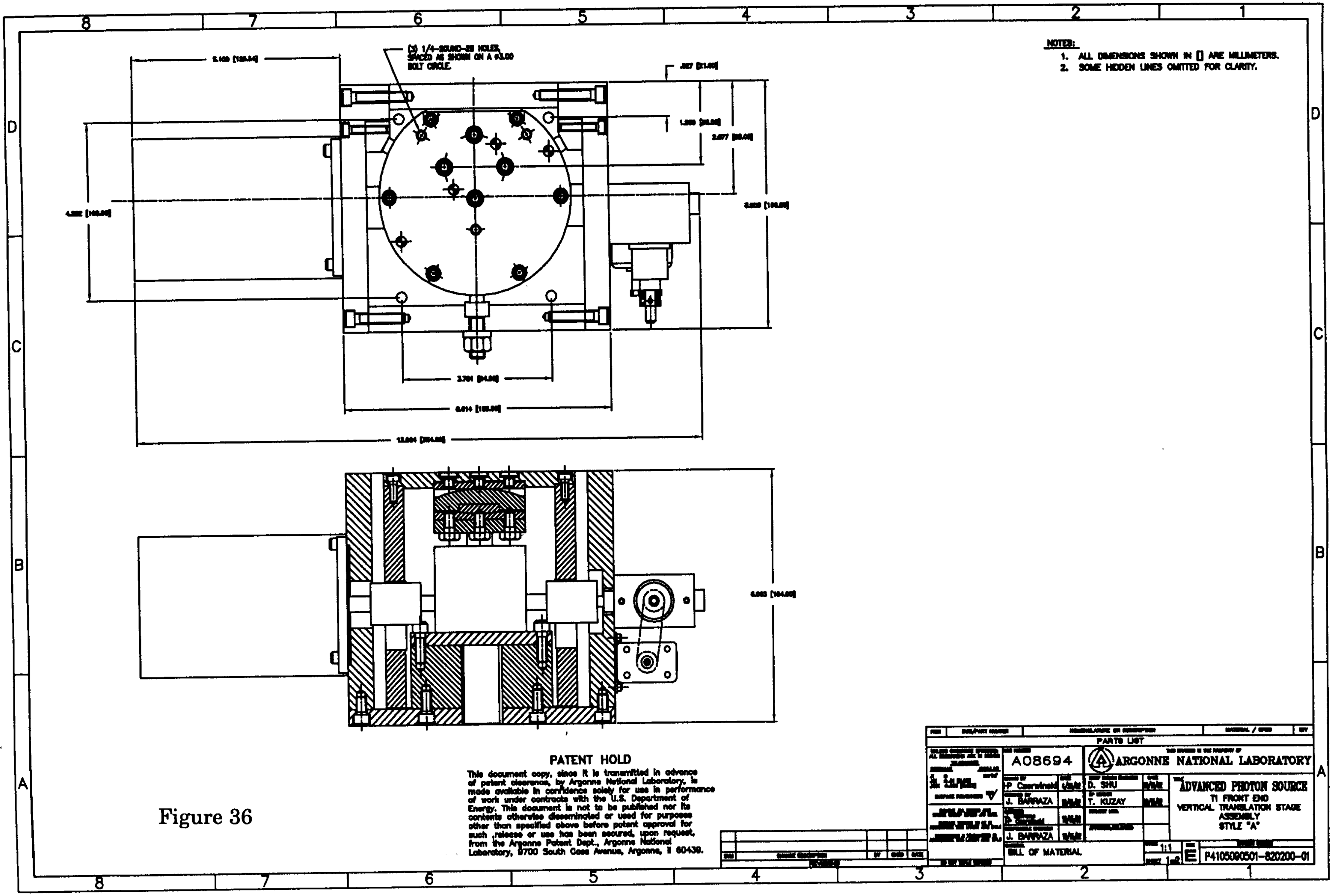


Figure 35 SUPPORT BASE WITH PRECISION KINEMATIC MOUNT STAGES


NOTES:
1. ALL DIMENSIONS SHOWN IN [] ARE MILLIMETERS.
2. SOME HIDDEN LINES OMITTED FOR CLARITY.
(3) 1/4-20UNC-2B HOLES, SPACED AS SHOWN ON A Ø3.00 BOLT CIRCLE.
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PARTS LIST
A08694
ARGONNE NATIONAL LABORATORY
P Czerwinski
J. BARRAZA
J. BARRAZA
D. SHU
T. KUZAY
ADVANCED PHOTON SOURCE
T1 FRONT END
VERTICAL TRANSLATION STAGE
ASSEMBLY
STYLE "A"
BILL OF MATERIAL
1:1
E
P4105090501-820200-01

Figure 36

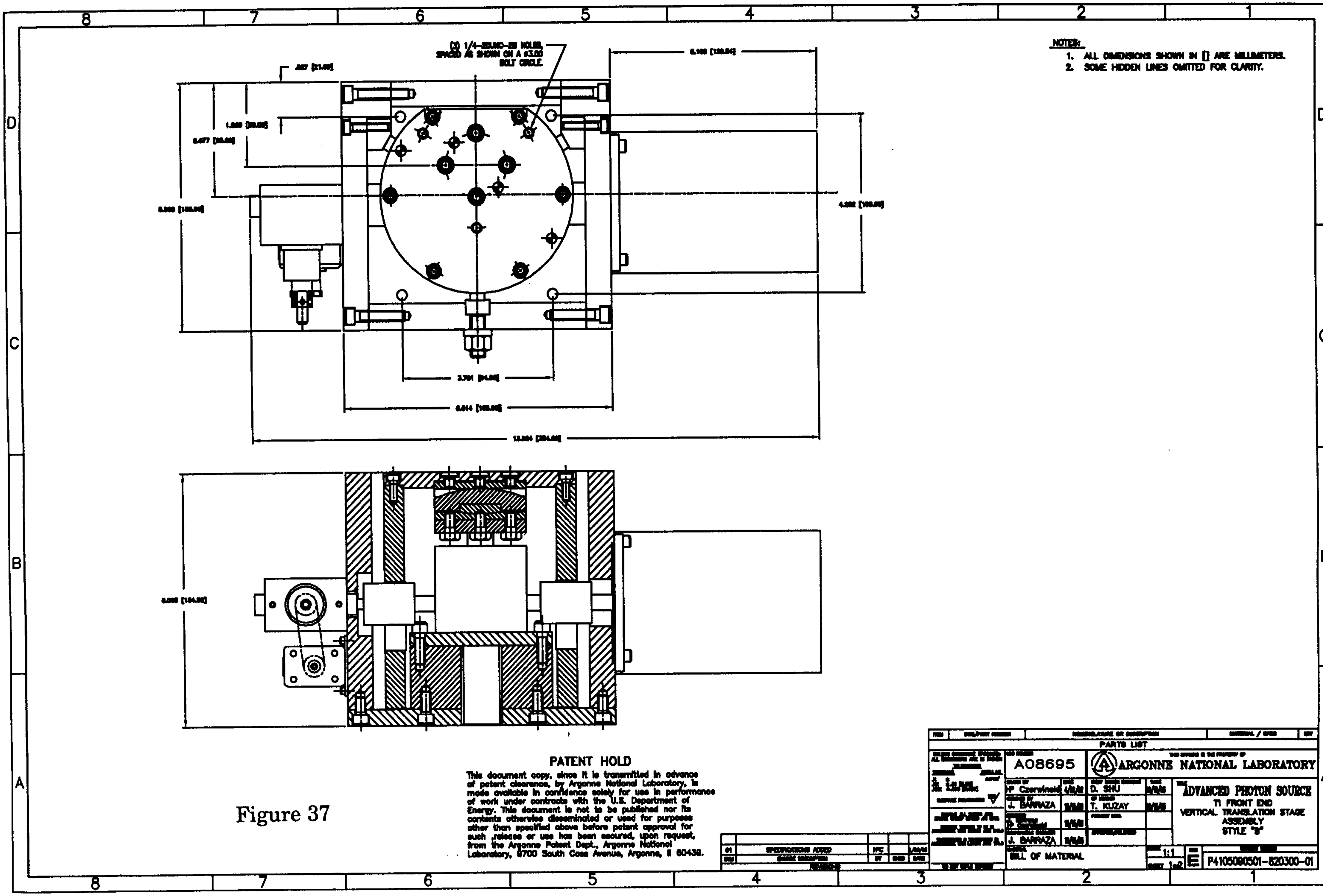

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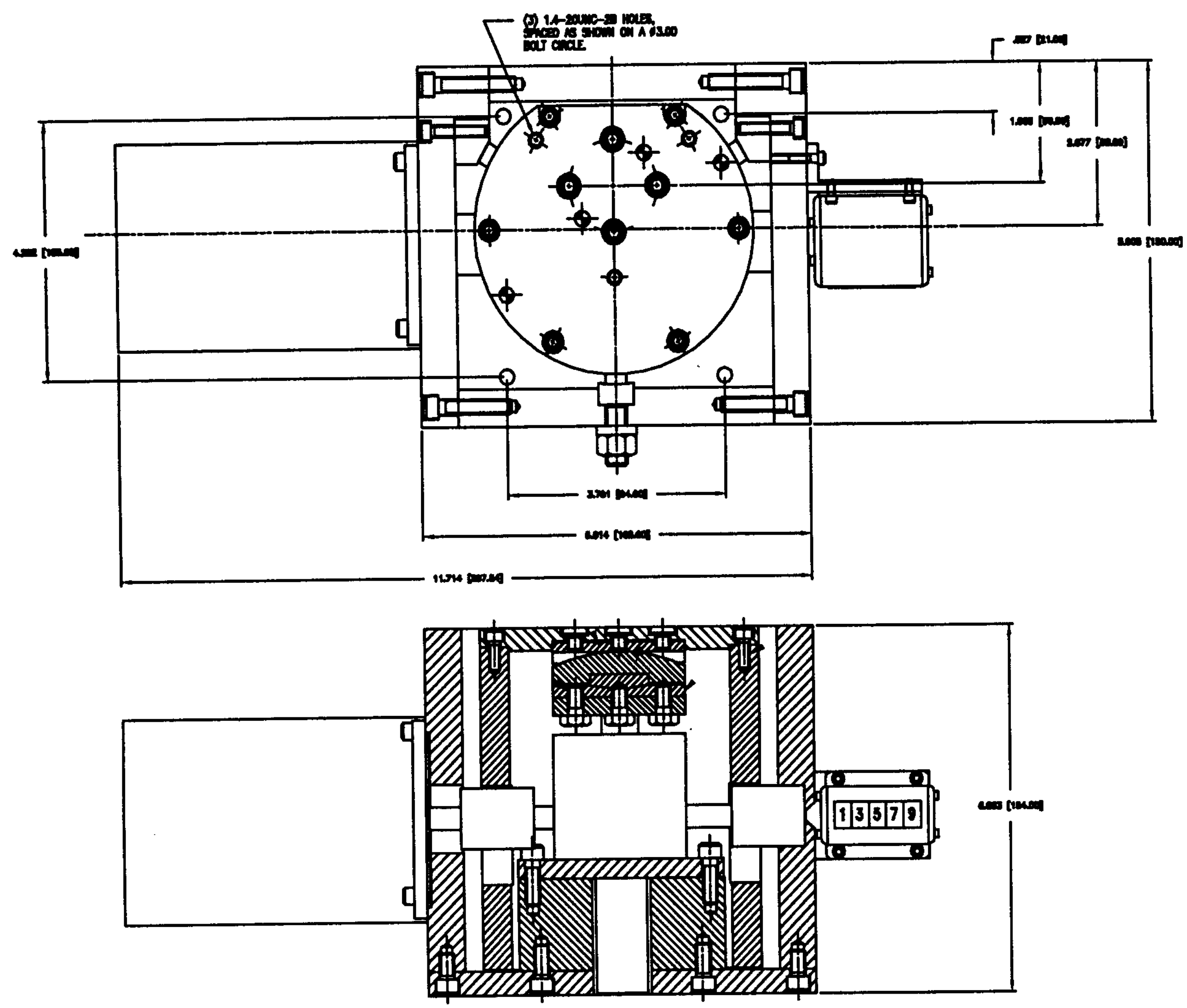
Figure 37



NOTES:
1. ALL DIMENSIONS SHOWN IN [] ARE MILLIMETERS.
2. SOME HIDDEN LINES OMITTED FOR CLARITY.

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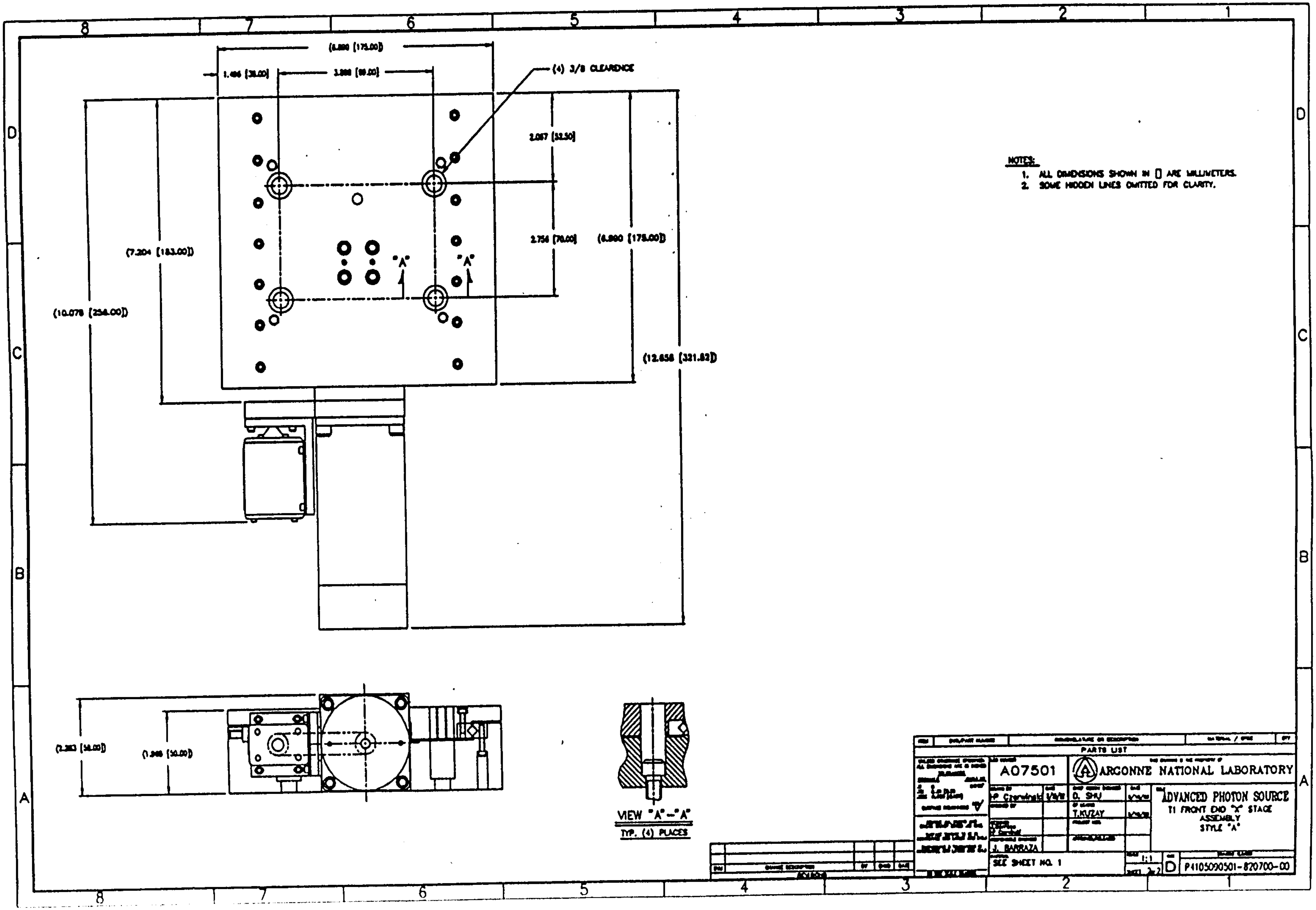
Figure 38

PARTS LIST
A08696
ARGONNE NATIONAL LABORATORY
P Czerwinski | D. SHU
J. BARRAZA | T. KUZAY
J. BARRAZA
ADVANCED PHOTON SOURCE
T1 FRONT END
VERTICAL TRANSLATON STAGE
ASSEMBLY
STYLE "C"
BILL OF MATERIAL
1:1
E
P4105090501-820400-01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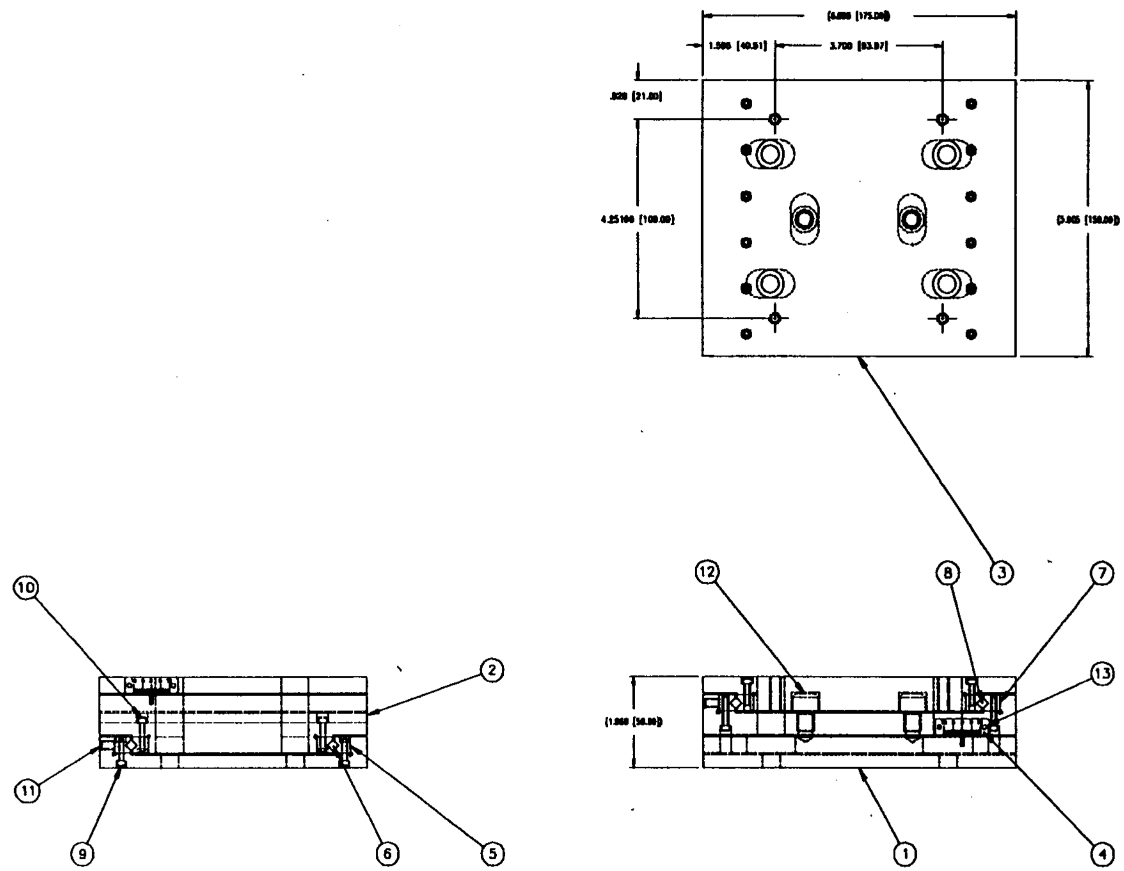
1.496 [38.00]
3.898 [99.00]
(4) 3/8 CLEARENCE
2.087 [53.50]
2.756 [70.00]
(6.890 [175.00])
(7.204 [183.00])
(10.078 [256.00])
(12.658 [321.52])
"A"
"A"
(2.283 [58.00])
(1.969 [50.00])
VIEW "A"-"A"
TYP. (4) PLACES
NOTES:
1. ALL DIMENSIONS SHOWN IN [] ARE MILLIMETERS.
2. SOME HIDDEN LINES OMITTED FOR CLARITY.
PARTS LIST
A07501
ARGONNE NATIONAL LABORATORY
ADVANCED PHOTON SOURCE
T1 FRONT END "X" STAGE
ASSEMBLY
STYLE "A"
D. SHU
T.KUZAY
J. BARRAZA
SEE SHEET NO. 1
1:1
D
P4105090501-820700-00

NOTE:

1. ITEM NO'S 4 & 13 ARE TO BE MOUNTED IN AREAS SHOWN. DRILL (4) ⌀.082 HOLES X .25 DEEP.
2. ALL DIMENSIONS SHOWN IN [] ARE MILLIMETERS.
3. SOME HIDDEN LINES OMITTED FOR CLARITY.



TECHNICAL SPECIFICATIONS:

1. PRIOR TO ASSEMBLY, ALL MACHINED PARTS MUST BE FREE OF GREASE, OIL, DUST, LINT AND ALL FOREIGN MATTER. SPECIAL ATTENTION SHOULD BE PAYED TO THE BEARING SURFACES.
2. PRIOR TO FITTING , ALL LINEAR BEARINGS MUST BE WASHED WITH A CLEANING AGENT THEN OILED LIGHTLY.

BEARING ASSEMBLY PROCEDURES:

1. FIT BEARING RAILS UNTO THEIR BASE AND SECURE LIGHTLY WITH SCREWS.
2. INSERT ROLLER CAGES AND CENTER ALONG BEARING RAILS.
3. ADJUST PRELOAD BAR USING SET SCREWS UNTIL PLAY FREE, THEN PRELOAD EACH SET SCREW TO APPROX. 10-30 lbf. TIGHTEN TO APPROX. 1in-lb.
4. SECURE SCREWS ON BEARING RAILS TIGHTLY USING A TORQUE WRENCH.

SPECIFICATIONS:

1. LOAD CAPACITY: 1000 LBS. [454 kg].
2. TRAVEL RANGE: ±1/4 [6.35]
3. RESOLUTION: 10 μm
4. REPEATABILITY: 50 μm
5. STRAIGHTNESS OF TRAJECTORY: 1x10-4 rad PER 25 mm.

13		#0 X .25 LG. TYPE "U" DRIVE SCREW	STN. STL.	4
12		3/8-16UNC-2A X .406 LG. CAP SCREW	304 STN. STL.	2
11		10-32UNF-2A X .31 LG. SET SCREW	304 STN. STL.	13
10		M3 X 16mm LG. CAP SCREW	304 STN. STL.	26
9		M3 X 12mm LG. CAP SCREW	304 STN. STL.	20
8	KBN4X-21	ROLLER CAGE	"SCHNEEBERGER"	2
7	RNG 4 150	BEARING RAIL	"SCHNEEBERGER"	4
6	KBN4X-25	ROLLER CAGE	"SCHNEEBERGER"	2
5	RNG 4 175	LINEAR BEARING RAIL	"SCHNEEBERGER"	4
4	P4105080501-820500	GAGE MARKER	304 STN. STL.	2
3	P4105080501-820602	TOP PLATE	6061 ALUMINUM	1
2	P4105080501-820601	MIDDLE PLATE	6061 ALUMINUM	1
1	P4105080501-820501	BASE PLATE	6061 ALUMINUM	1

PARTS LIST

A08698

ARGONNE NATIONAL LABORATORY

P. Czerwinski | D. SHU
J. BARRAZA | T. KUZAY
J. BARRAZA

ADVANCED PHOTON SOURCE
11 FRONT END "X"-"Y" STAGE
STYLE "B"
ASSEMBLY

SEE BILL OF MATERIAL

1:1

E

P4105090501-820600-01

Figure 39

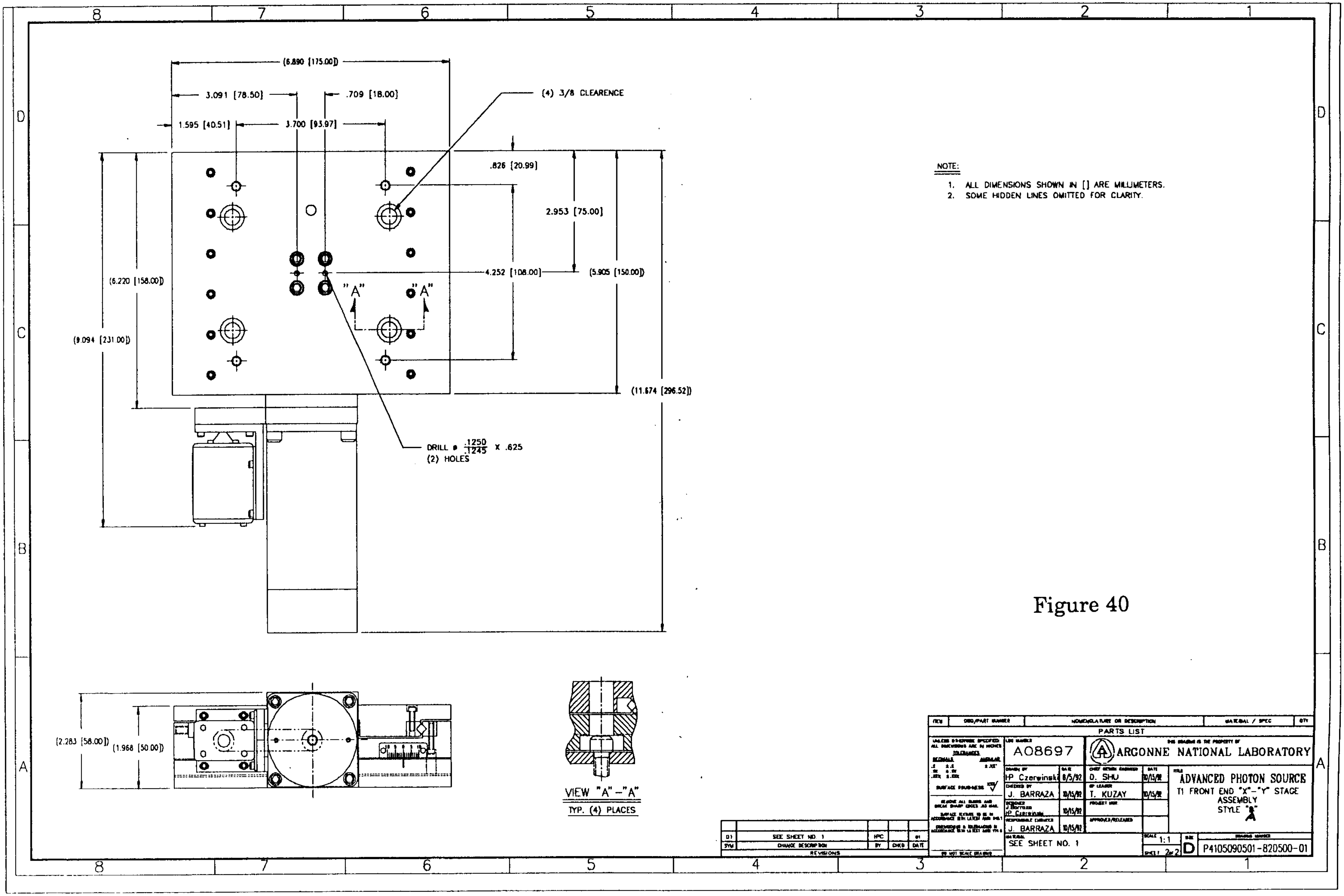

(6.890 [175.00])
3.091 [78.50]
.709 [18.00]
(4) 3/8 CLEARENCE
1.595 [40.51]
3.700 [93.97]
.826 [20.99]
2.953 [75.00]
4.252 [108.00]
(5.905 [150.00])
(6.220 [158.00])
(9.094 [231.00])
(11.674 [296.52])
"A"
"A"
DRILL ⌀ .1250/.1245 X .625
(2) HOLES
NOTE:
1. ALL DIMENSIONS SHOWN IN [] ARE MILLIMETERS.
2. SOME HIDDEN LINES OMITTED FOR CLARITY.
(2.283 [58.00])
(1.968 [50.00])
VIEW "A"-"A"
TYP. (4) PLACES
PARTS LIST
A08697
ARGONNE NATIONAL LABORATORY
P Czerwinski
8/5/92
D. SHU
10/15/92
J. BARRAZA
10/15/92
T. KUZAY
10/15/92
J. BARRAZA
10/15/92
ADVANCED PHOTON SOURCE
T1 FRONT END "X"-"Y" STAGE
ASSEMBLY
STYLE "A"
SEE SHEET NO. 1
1:1
D
P4105090501-820500-01
SEE SHEET NO. 1
CHANGE DESCRIPTION
REVISIONS

Figure 40

FE PBPM SUPPORT TABLE SPECIFICATIONS

Max. Load (Kg)	90
Slide Type (V)	Linear Rolling
Slide Type (H)	Linear Rolling
Travel Range (V) (H) (mm)	12.7
Motion (V) Resolution (um)	0.1
Motion (H) Resolution (um)	0.1
Motion (V) Repeatability (um)	2
Motion (H) Repeatability (um)	2
(V) Straightness of Trajectory (rad/5mm)	1 E -5
(H) Straightness of Trajectory (rad/5mm)	1 E -5
Basic Operating Mode	Stepping Motor
Optional Operating Mode	Manual

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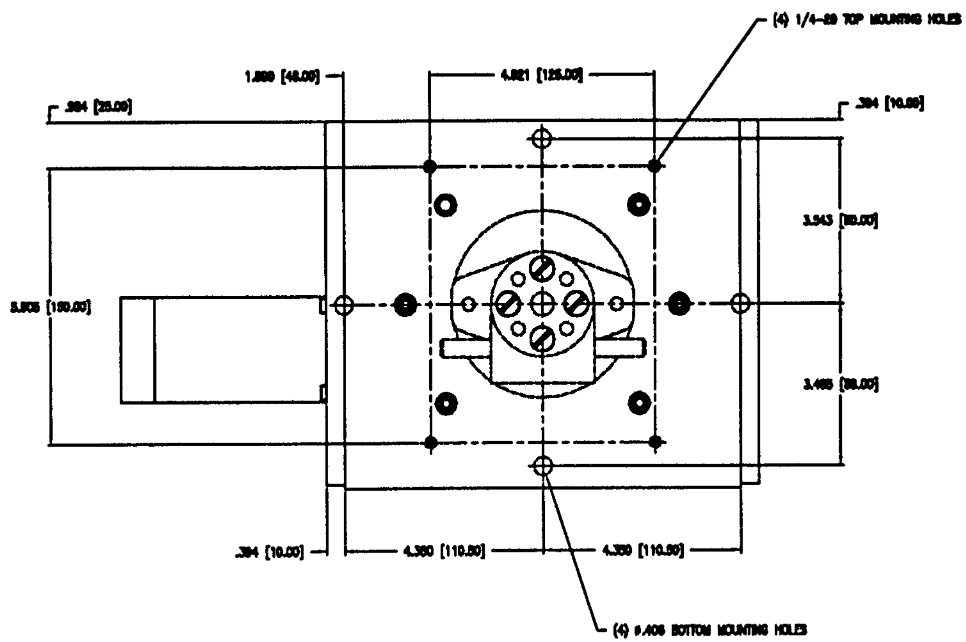


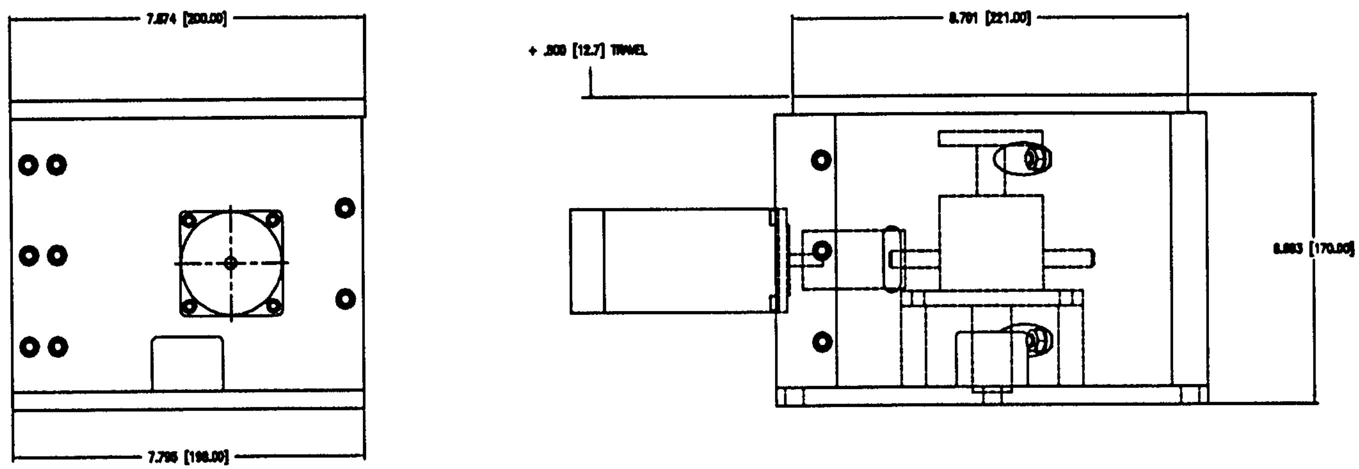
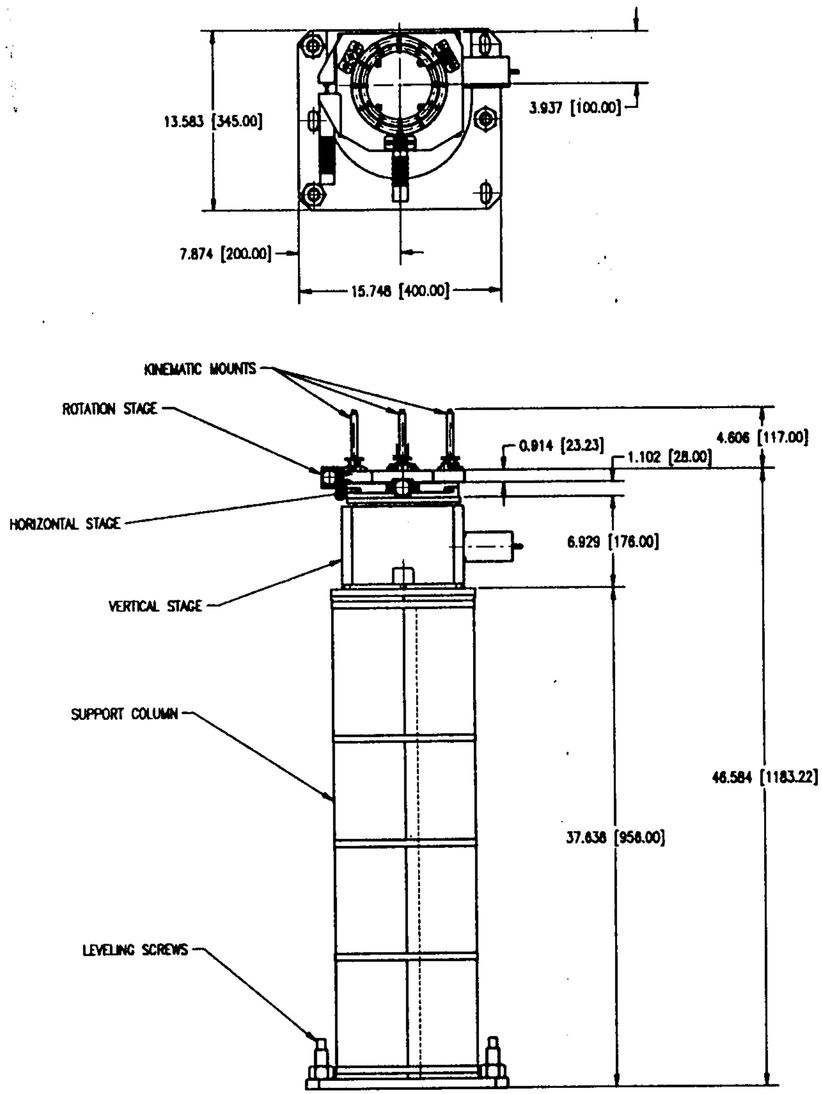


Figure 41 PBPM VERTICAL STAGE ASSEMBLY



SPECIFICATIONS:

1. LOAD CAPACITY: 90 kg
2. TRAVEL RANGE: +/- 5 mm
3. RESOLUTION: 0.1 - 0.5 μm
4. REPEATABILITY: VERTICAL: +/- 2 μm
   HORIZONTAL: +/- 5 μm
5. ANGULAR RESOLUTION: 5 ARCSECONDS
6. STRAIGHTNESS OF TRAJECTORY: 1×10^{-5} RAD/25 mm

Figure 42 PBPM SUPPORT TABLE ASSEMBLY

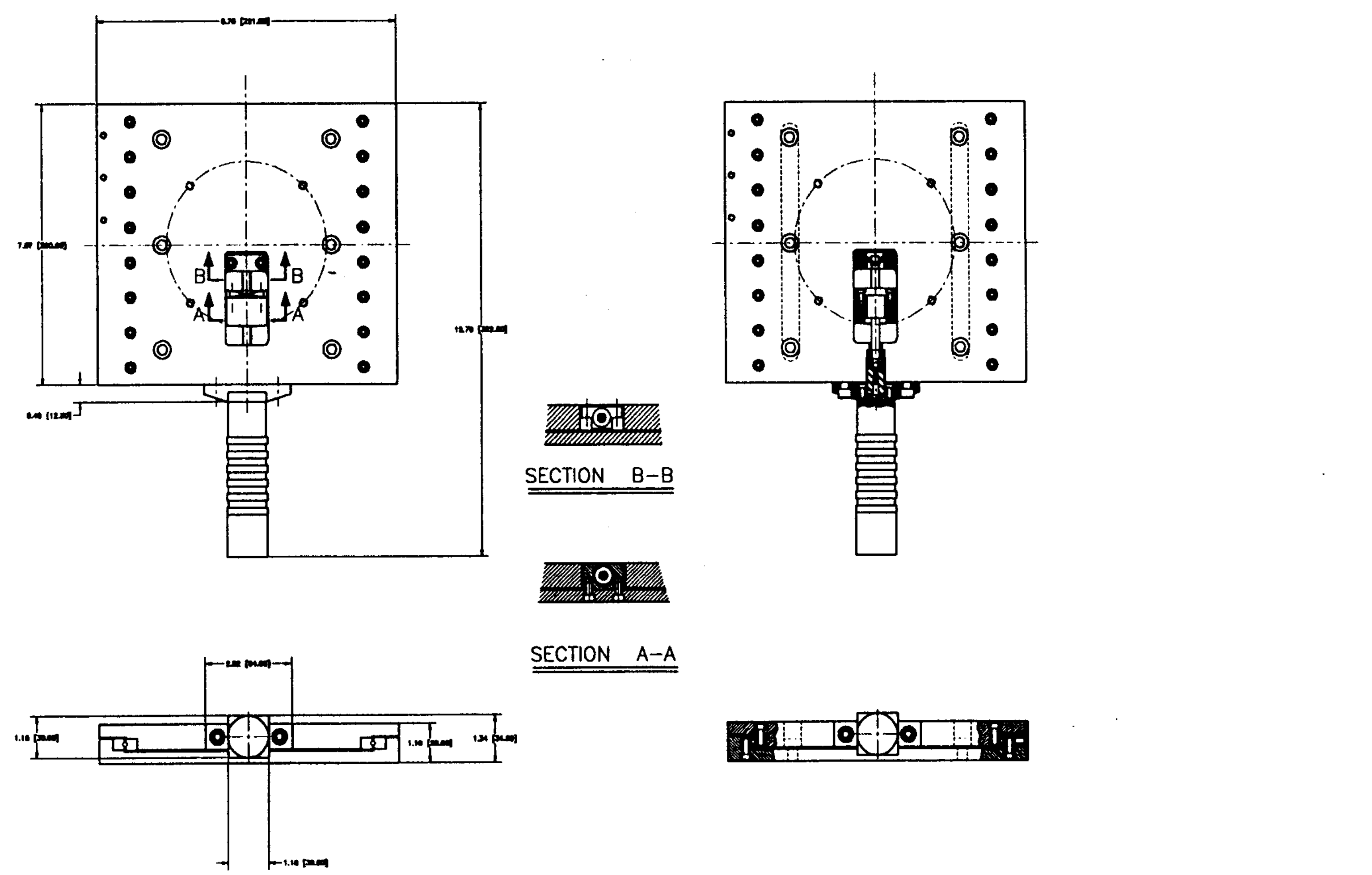


Figure 43 PBPM HORIZONTAL STAGE ASSEMBLY

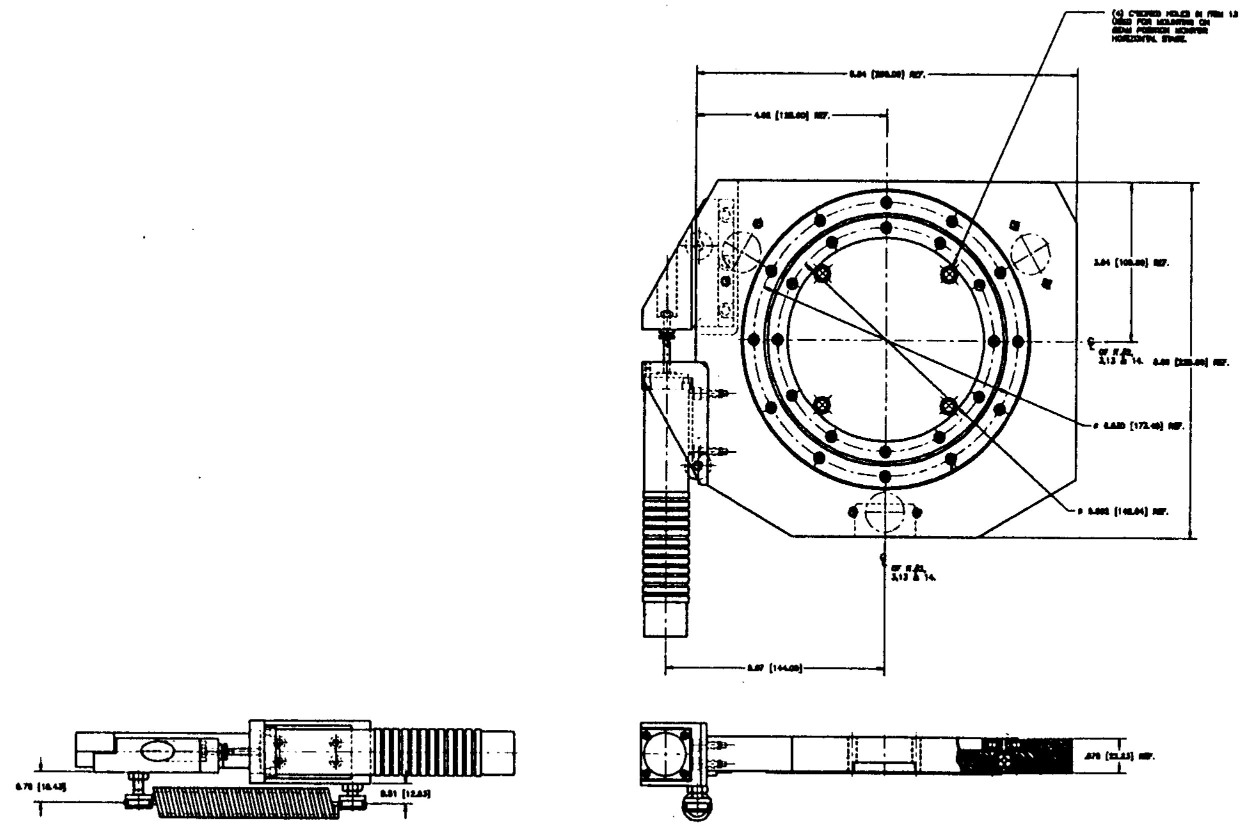


Figure 44 PBPM ROTATION STAGE ASSEMBLY

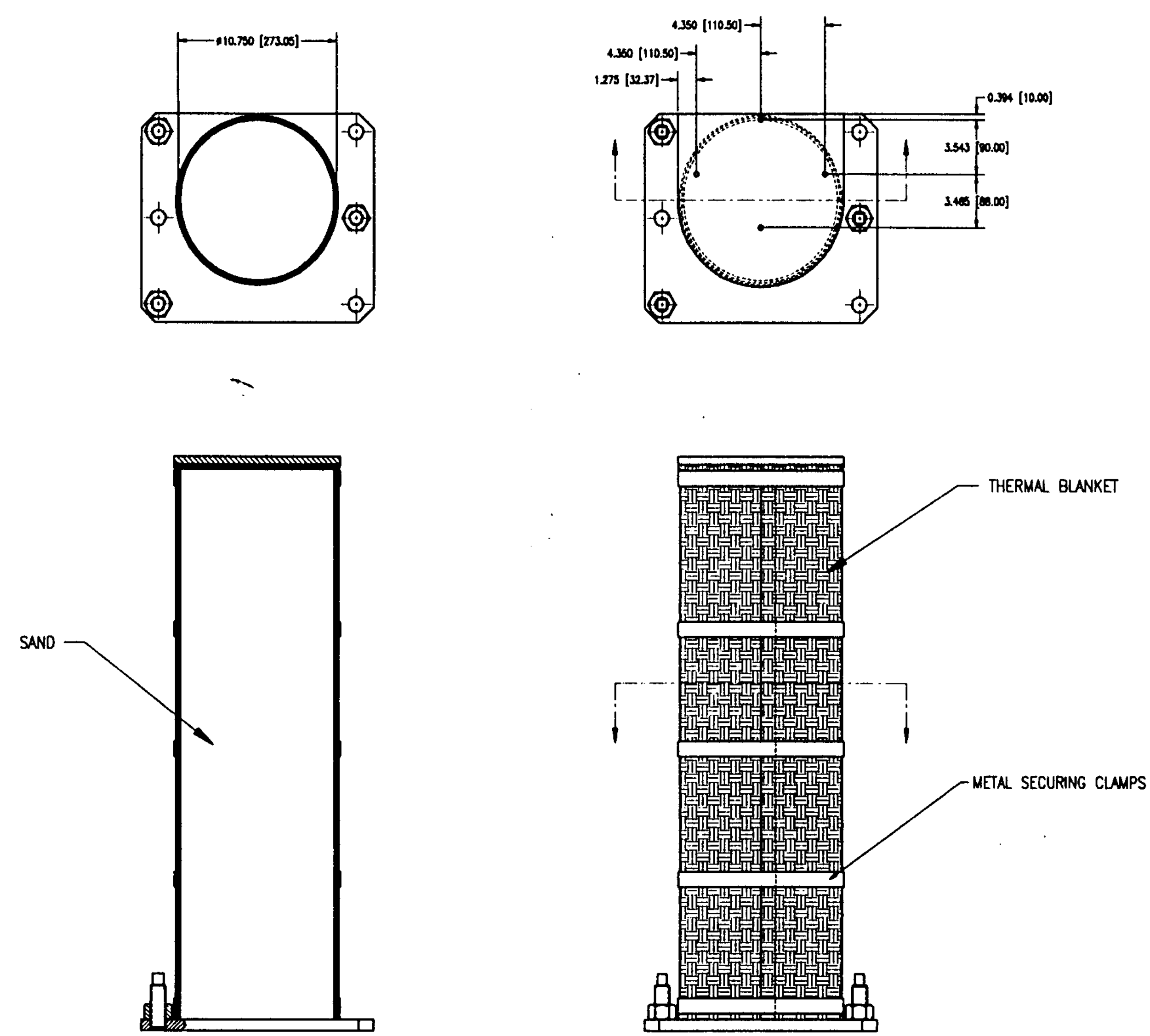


Figure 45 PBPM SUPPORT COLUMN ASSEMBLY

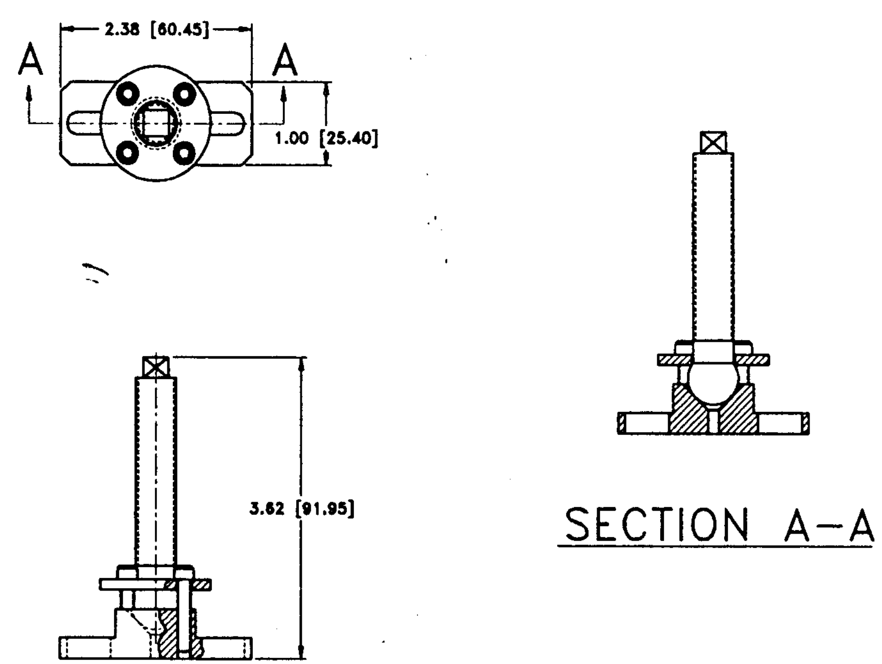


Figure 46 PBPM KINEMATIC MOUNT CONE ASSEMBLY

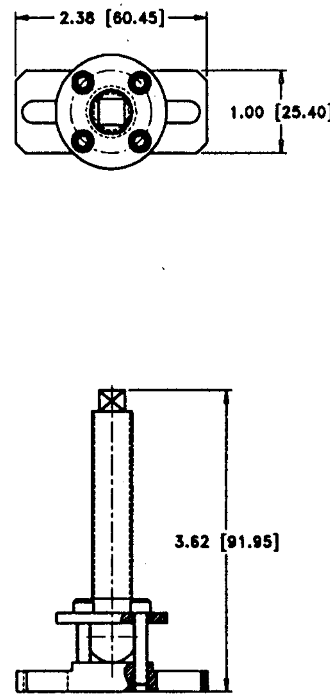


Figure 47 PBPM KINEMATIC MOUNT FLAT ASSEMBLY

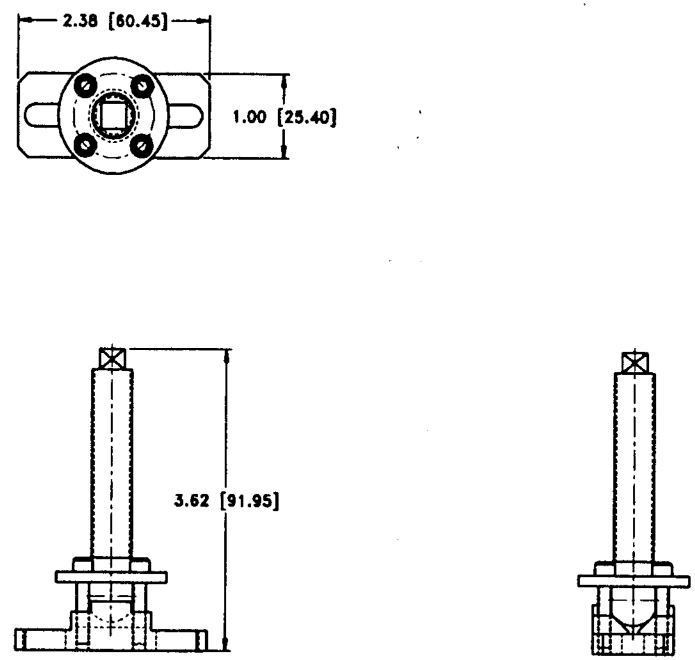


Figure 48 PBPM KINEMATIC MOUNT V ASSEMBLY

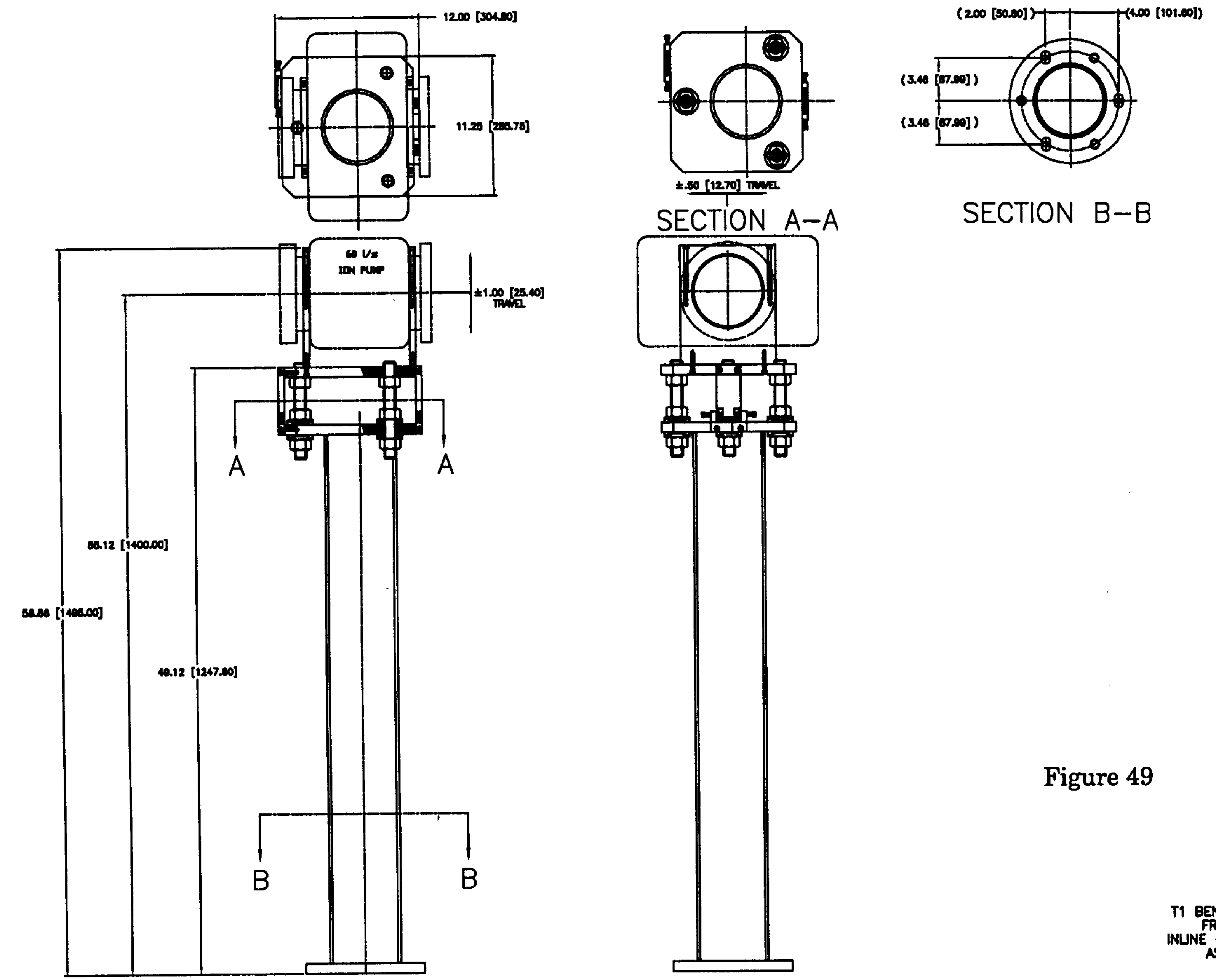


Figure 49

T1 BENDING MAGNET
FRONT END
INLINE ION PUMP SUPP
ASSEMBLY

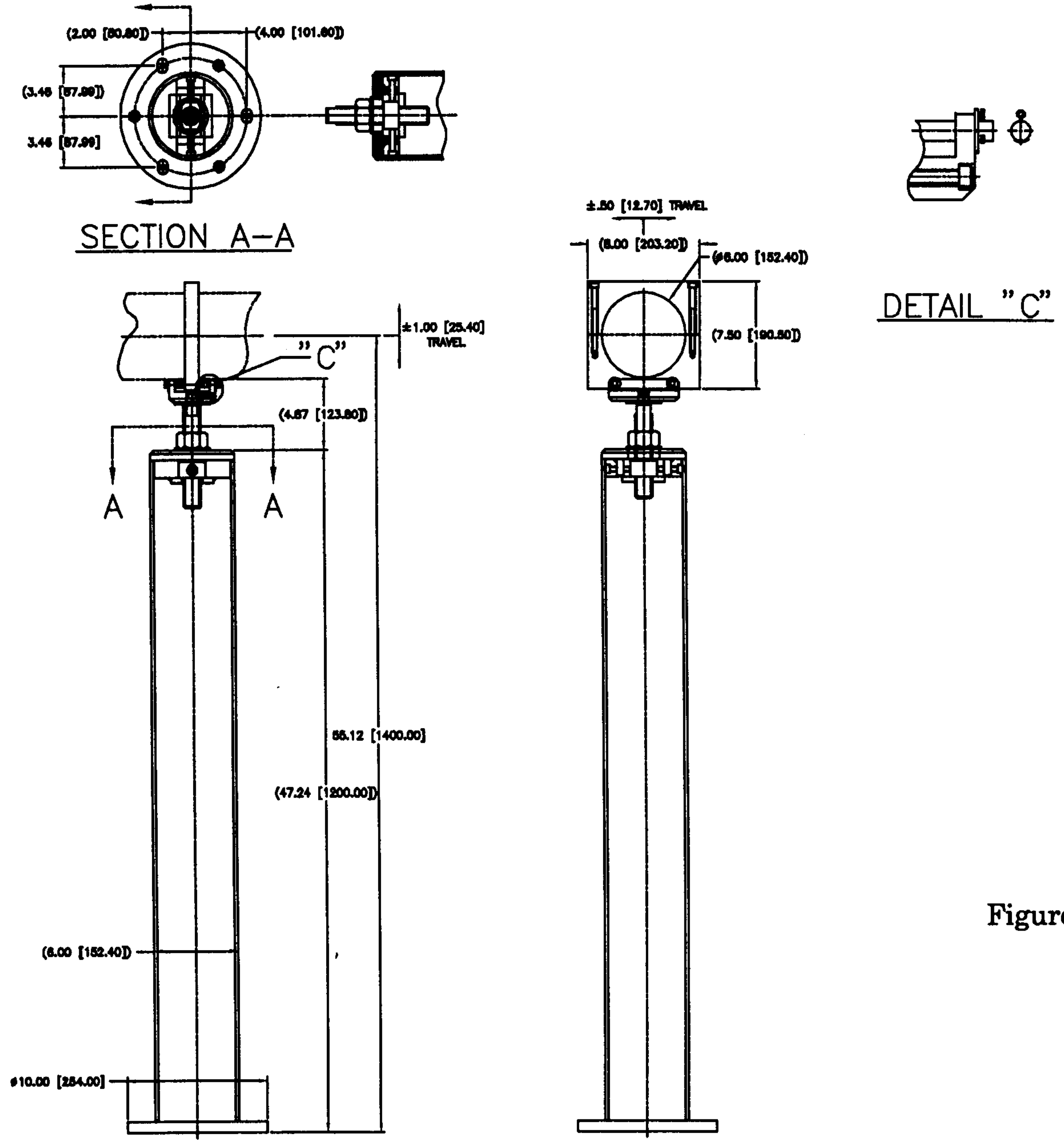


Figure 50

T1 BENDING MAGNET
FRONT END
BEAM PIPE SUPPORT
ASSEMBLY

10. Stepping Motor Drives

10.1. Stepping motors (being developed)

10.2. Drivers/Controllers (being developed)

Design Status

The APS user organization has appointed a subcommittee to advise the APS in developing standard recommendations for stepping motors, drivers, and controllers. It is expected that the committee will provide their recommendation before the end of 1993 by working closely with the APS. The standardisation is also closely linked to anew software development work at the APS that uses Experimental Physics Interface Control System (EPICS).

As a starting point, the APS has used the stepping motor/drivers specified in section 10.1 - 10.2, which are used in all standard supports (section 9).

10.1. - 10.2. Stepping Motors - Drivers/Controllers

- Standardize stepping motor drives and controllers
- Control for multi-motor driven systems
- Open and/or closed loop control
- Acceleration and deceleration control
- Power fail-safe control with battery backup coordinate memory

The APS stepping motor driver/controller is designed to provide a user friendly control environment for multi-motor driven systems such as kinematic mounting tables or beamline slits. Control is to be either manual or through computer control.

Specifications:

- Stepping motor:	four phase, 400 half steps/rev, 3% accuracy M063-LE06-E: 3.36 V DC, 2.9 A M093-FD8107-E: 4.3V, 3.5A
- Maximum stepping rate:	40000 half steps/sec
- Able to interface with computer	
- Position display:	seven digit and sign with computer conversion
- Feedback:	open and/or closed loop with TTL incremental encoder signals
- Memory backup:	battery backup nonvolatile memory of control data
- Power fail safe	
- Switch status information to host:	open or closed of limits or home
- Connectors	(to be standardized)
- Cables	(to be standardized)

11. Interlock - Interfaces

11.1. Switches
11.2. Solenoids
11.3. Interfaces - cables and connectors
11.3.1. Ion pumps with power supplies
11.3.2. Ion gauges with power supplies
11.3.3. Vacuum valves

<u>Design Status</u>

Work will be completed by the end of 1993.

12. Actuators

12.1. Heavy load with stepping motor drive
12.2. Heavy load with pneumatic drive
12.3. Light load with stepping motor drive
12.4. Light load with pneumatic drive

Design Status

The design work on all the actuators is in advanced stage, and prototypes will be built and tested in 1993. The following sections include various design specifications.

12.1. APS Heavy Load Actuator with Stepping Motor Drive

SLAH-30-8, SLAH-75-8
(A2-81) (A2-82)

- Heavy load actuators
- For use with APS ID white beam slits
- Stepping motor driven with shaft encoder

A typical application for these actuators is to drive APS ID white beam slits. There are three different ranges of travel designed.

Specifications:

- Slide type:	Linear rolling
- Travel ranges:	30 & 75 mm
- Motion resolution:	2 μm
- Motion reproducibility:	5 μm
- Straightness:	2 x 10^{-4} rad/25 mm
- Vacuum load:	38 kg
- Maximum useful axial load:	100 kg
- Stepping motor:	Slo-Syn M092-LE06
- Actuator flange O. D.:	8 inch
- Feedthrough flange O. D.:	4.5 inch
- Maximum feedthrough diameter:	50 mm
- Redundant limit switches	
-Encoder:	Optical on motor shaft and/or linear on slide
-Maximum speed:	20 mm/min
-Vacuum:	UHV compatible

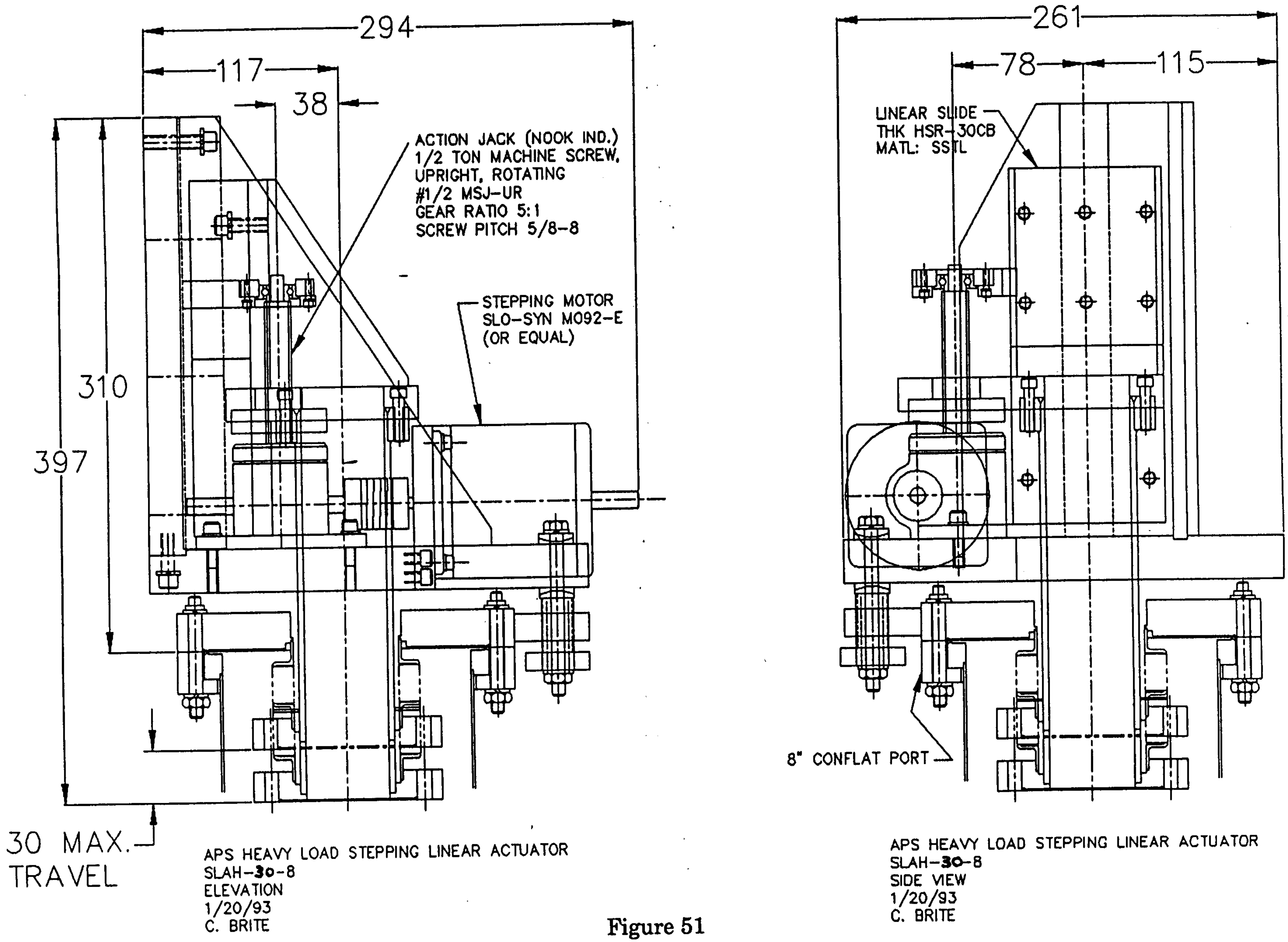
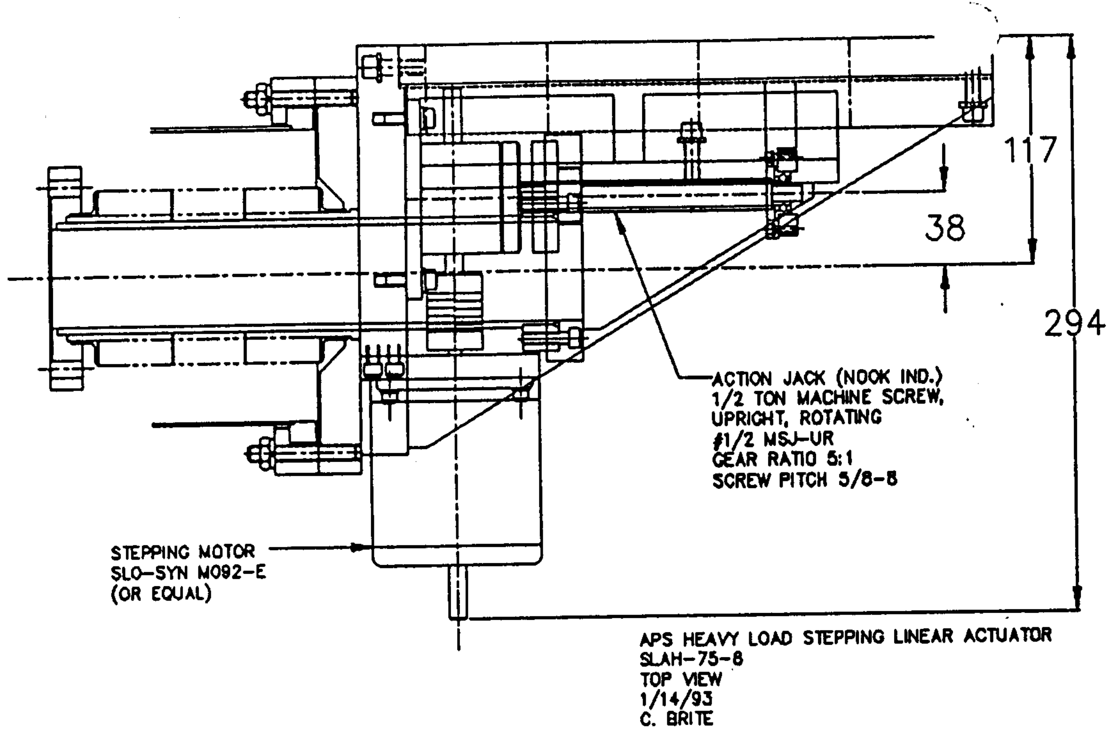
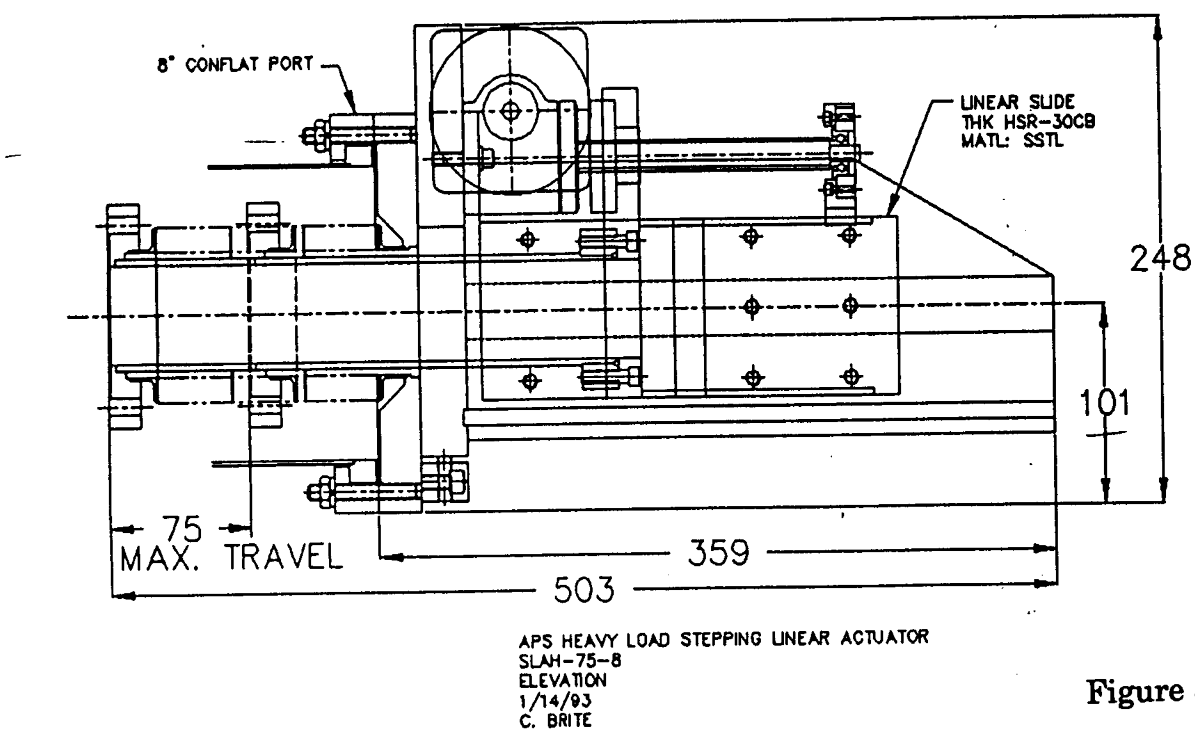

294
117
38
310
397
30 MAX.
TRAVEL
ACTION JACK (NOOK IND.)
1/2 TON MACHINE SCREW,
UPRIGHT, ROTATING
#1/2 MSJ-UR
GEAR RATIO 5:1
SCREW PITCH 5/8-8
STEPPING MOTOR
SLO-SYN M092-E
(OR EQUAL)
APS HEAVY LOAD STEPPING LINEAR ACTUATOR
SLAH-30-8
ELEVATION
1/20/93
C. BRITE
261
78
115
LINEAR SLIDE
THK HSR-30CB
MATL: SSTL
8" CONFLAT PORT
APS HEAVY LOAD STEPPING LINEAR ACTUATOR
SLAH-30-8
SIDE VIEW
1/20/93
C. BRITE

Figure 51


117
38
294
ACTION JACK (NOOK IND.)
1/2 TON MACHINE SCREW,
UPRIGHT, ROTATING
#1/2 MSJ-UR
GEAR RATIO 5:1
SCREW PITCH 5/8-8
STEPPING MOTOR
SLO-SYN M092-E
(OR EQUAL)
APS HEAVY LOAD STEPPING LINEAR ACTUATOR
SLAH-75-8
TOP VIEW
1/14/93
C. BRITE


8" CONFLAT PORT
LINEAR SLIDE
THK HSR-30CB
MATL: SSTL
248
101
75
MAX. TRAVEL
359
503
APS HEAVY LOAD STEPPING LINEAR ACTUATOR
SLAH-75-8
ELEVATION
1/14/93
C. BRITE

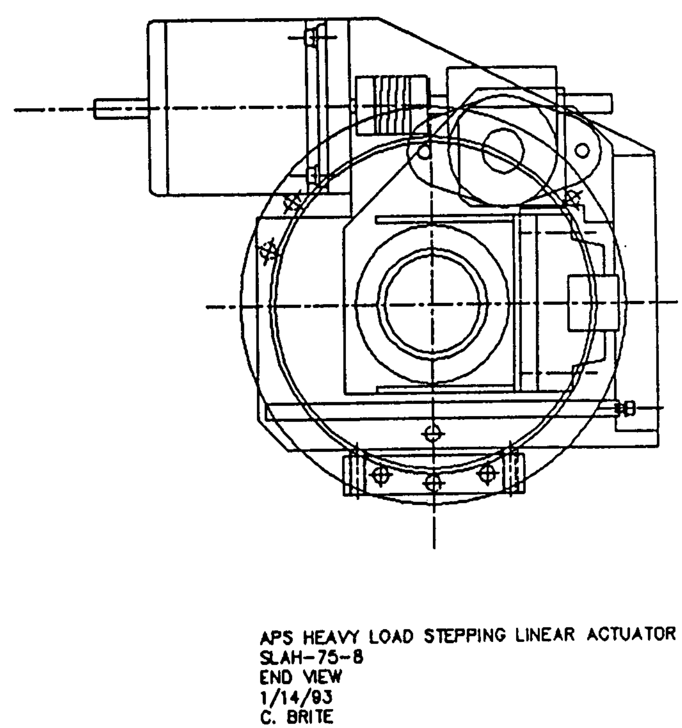

APS HEAVY LOAD STEPPING LINEAR ACTUATOR
SLAH-75-8
END VIEW
1/14/93
C. BRITE

Figure 52

12.2. APS Heavy Load Actuator with Pneumatic Drive

PLAH-33-10

- Heavy load actuators
- For use with APS ID and BM front end and beamline safety shutters

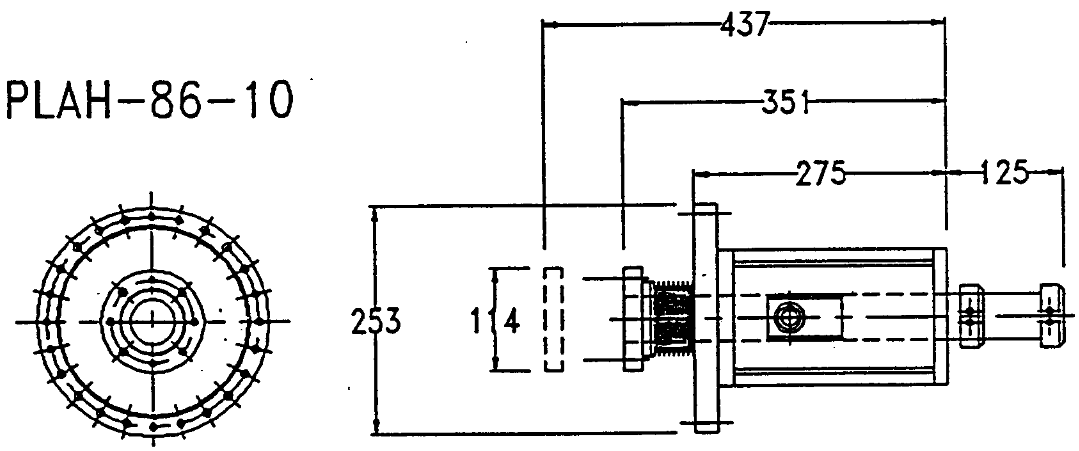
A typical application for the heavy load pneumatic actuators is to drive APS safety shutters.

Specifications:

- Stroke:	33 mm ± 0.25 mm
- Motion repeatability:	0.5 mm ± 0.1 mm
- Total axial load:	190 kg
- Vacuum load:	40 kg
- Maximum useful axial load:	70 kg
- Chamber flange O. D.:	8 inch
- Rod flange O. D.:	4.5 inch
- Redundant limit switches in each end position	Micro switch BZZRQ2X-A2
- Pneumatic power supply:	90 - 120 psi
- Maximum closing time:	0.5 - 1 sec
- Pneumatic damping:	in each end position
- Life time:	500k cycles
-Vacuum:	UHV compatible

ADVANCED PHOTON SOURCE DRAFT

APS HEAVY LOAD PNEUMATIC LINEAR ACTUATOR



PLAH.DWG 01-18-92

Figure 53

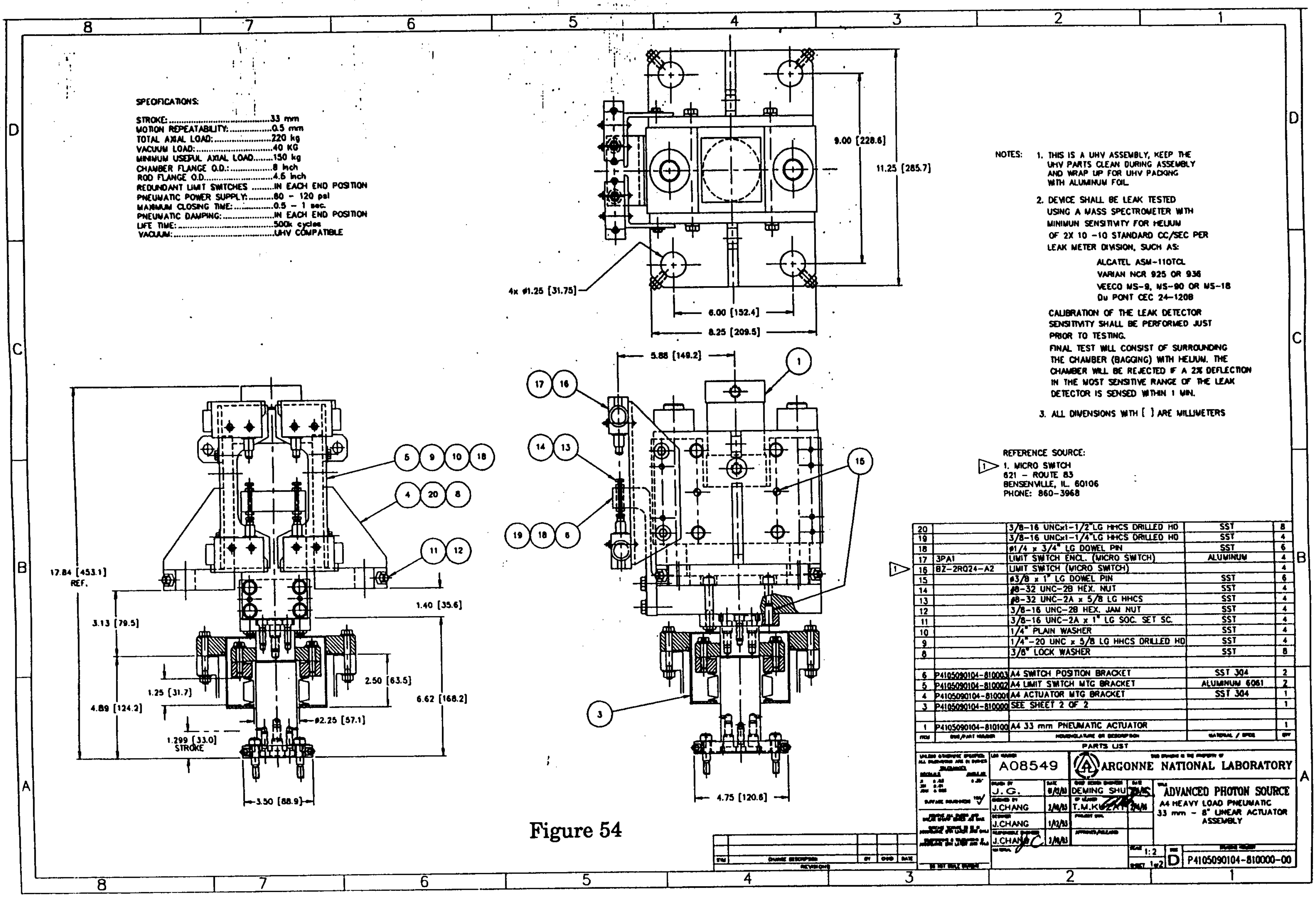

SPECIFICATIONS:
STROKE: 33 mm
MOTION REPEATABILITY: 0.5 mm
TOTAL AXIAL LOAD: 220 kg
VACUUM LOAD: 40 KG
MINIMUM USEFUL AXIAL LOAD 150 kg
CHAMBER FLANGE O.D.: 8 inch
ROD FLANGE O.D. 4.6 inch
REDUNDANT LIMIT SWITCHES IN EACH END POSITION
PNEUMATIC POWER SUPPLY: 80 - 120 psi
MAXIMUM CLOSING TIME: 0.5 - 1 sec.
PNEUMATIC DAMPING: IN EACH END POSITION
LIFE TIME: 500k cycles
VACUUM: UHV COMPATIBLE
NOTES: 1. THIS IS A UHV ASSEMBLY, KEEP THE UHV PARTS CLEAN DURING ASSEMBLY AND WRAP UP FOR UHV PACKING WITH ALUMINUM FOIL.
2. DEVICE SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUN SENSITIVITY FOR HELIUM OF 2X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS:
ALCATEL ASM-110TCL
VARIAN NCR 925 OR 936
VEECO MS-9, MS-90 OR MS-18
Du PONT CEC 24-120B
CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TESTING.
FINAL TEST WILL CONSIST OF SURROUNDING THE CHAMBER (BAGGING) WITH HELIUM. THE CHAMBER WILL BE REJECTED IF A 2% DEFLECTION IN THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
3. ALL DIMENSIONS WITH [ ] ARE MILLIMETERS
REFERENCE SOURCE:
1. MICRO SWITCH
621 - ROUTE 83
BENSENVILLE, IL. 60106
PHONE: 860-3968
9.00 [228.6]
11.25 [285.7]
4x ø1.25 [31.75]
6.00 [152.4]
8.25 [209.5]
5.88 [149.2]
17.84 [453.1] REF.
3.13 [79.5]
1.40 [35.6]
1.25 [31.7]
2.50 [63.5]
6.62 [168.2]
4.89 [124.2]
ø2.25 [57.1]
1.299 [33.0] STROKE
3.50 [88.9]
4.75 [120.6]
20 | | 3/8-16 UNCx1-1/2"LG HHCS DRILLED HD | SST | 8
19 | | 3/8-16 UNCx1-1/4"LG HHCS DRILLED HD | SST | 4
18 | | ø1/4 x 3/4" LG DOWEL PIN | SST | 6
17 | 3PA1 | LIMIT SWITCH ENCL. (MICRO SWITCH) | ALUMINUM | 4
16 | BZ-2RQ24-A2 | LIMIT SWITCH (MICRO SWITCH) | | 4
15 | | ø3/8 x 1" LG DOWEL PIN | SST | 6
14 | | #8-32 UNC-2B HEX. NUT | SST | 4
13 | | #8-32 UNC-2A x 5/8 LG HHCS | SST | 4
12 | | 3/8-16 UNC-2B HEX. JAM NUT | SST | 4
11 | | 3/8-16 UNC-2A x 1" LG SOC. SET SC. | SST | 4
10 | | 1/4" PLAIN WASHER | SST | 4
9 | | 1/4"-20 UNC x 5/8 LG HHCS DRILLED HD | SST | 4
8 | | 3/8" LOCK WASHER | SST | 8
6 | P4105090104-810003 | A4 SWITCH POSITION BRACKET | SST 304 | 2
5 | P4105090104-810002 | A4 LIMIT SWITCH MTG BRACKET | ALUMINUM 6061 | 2
4 | P4105090104-810001 | A4 ACTUATOR MTG BRACKET | SST 304 | 1
3 | P4105090104-810000 | SEE SHEET 2 OF 2 | | 1
1 | P4105090104-810100 | A4 33 mm PNEUMATIC ACTUATOR | | 1
PARTS LIST
A08549
ARGONNE NATIONAL LABORATORY
J.G.
DEMING SHU
T.M.K
J.CHANG
J.CHANG
J.CHANG
ADVANCED PHOTON SOURCE
A4 HEAVY LOAD PNEUMATIC
33 mm - 8" LINEAR ACTUATOR
ASSEMBLY
1:2
D
P4105090104-810000-00
REVISIONS

Figure 54

12.3. APS Light Load Actuator with Stepping Motor Drive

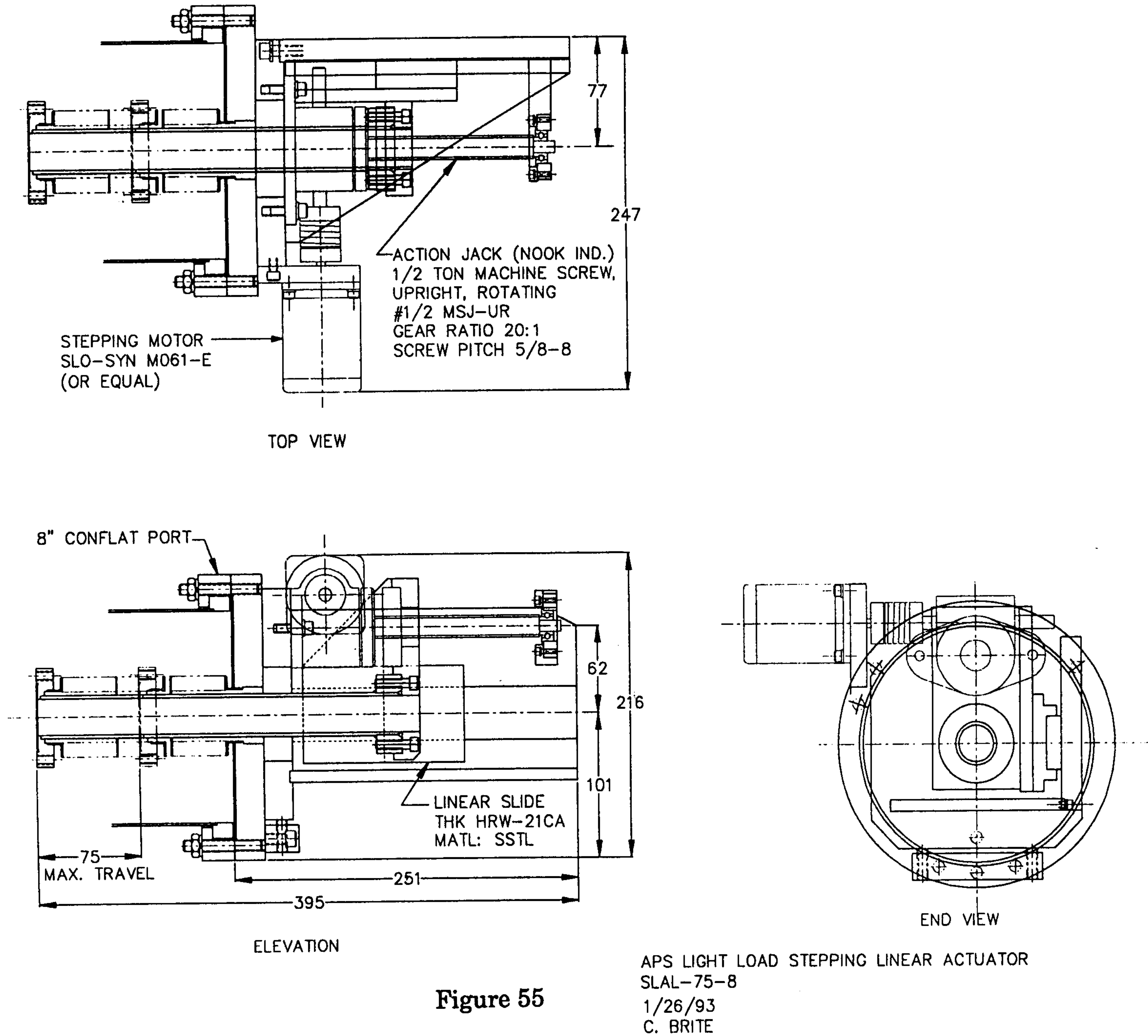
SLAL-30-8, SLAL-75-8, SLAL-150-8
(A1-81) (A1-82) (A1-83)

- Light load actuators
- For use with APS ID and BM monochromatic slits and BM white slits
- Stepping-motor driven with shaft encoder

A typical application for these actuators is to drive the APS monochromatic beam slits and BM white beam slits. There are three different ranges of travel designed.

Specifications:

- Slide type:	Linear rolling
- Travel ranges:	30, 75, and 150 mm
- Motion resolution:	1 μm
- Motion reproducibility:	5 μm
- Straightness:	2×10^{-4} rad/25 mm
- Vacuum load:	19 kg
- Maximum useful axial load:	10 kg
- Stepping motor:	Slo-Syn M061-LE06
- Actuator flange O. D.:	8 inch
- Feedthrough flange O. D.:	2.75 inch
- Maximum feedthrough diameter:	25 mm
- Redundant limit switches	
-Encoder:	Optical on motor shaft and/or linear on slide
-Maximum speed:	50 mm/min
-Vacuum:	UHV compatible



77
247
ACTION JACK (NOOK IND.)
1/2 TON MACHINE SCREW,
UPRIGHT, ROTATING
#1/2 MSJ-UR
GEAR RATIO 20:1
SCREW PITCH 5/8-8
STEPPING MOTOR
SLO-SYN M061-E
(OR EQUAL)
TOP VIEW
8" CONFLAT PORT
62
216
101
LINEAR SLIDE
THK HRW-21CA
MATL: SSTL
75
MAX. TRAVEL
251
395
ELEVATION
END VIEW
APS LIGHT LOAD STEPPING LINEAR ACTUATOR
SLAL-75-8
1/26/93
C. BRITE

Figure 55

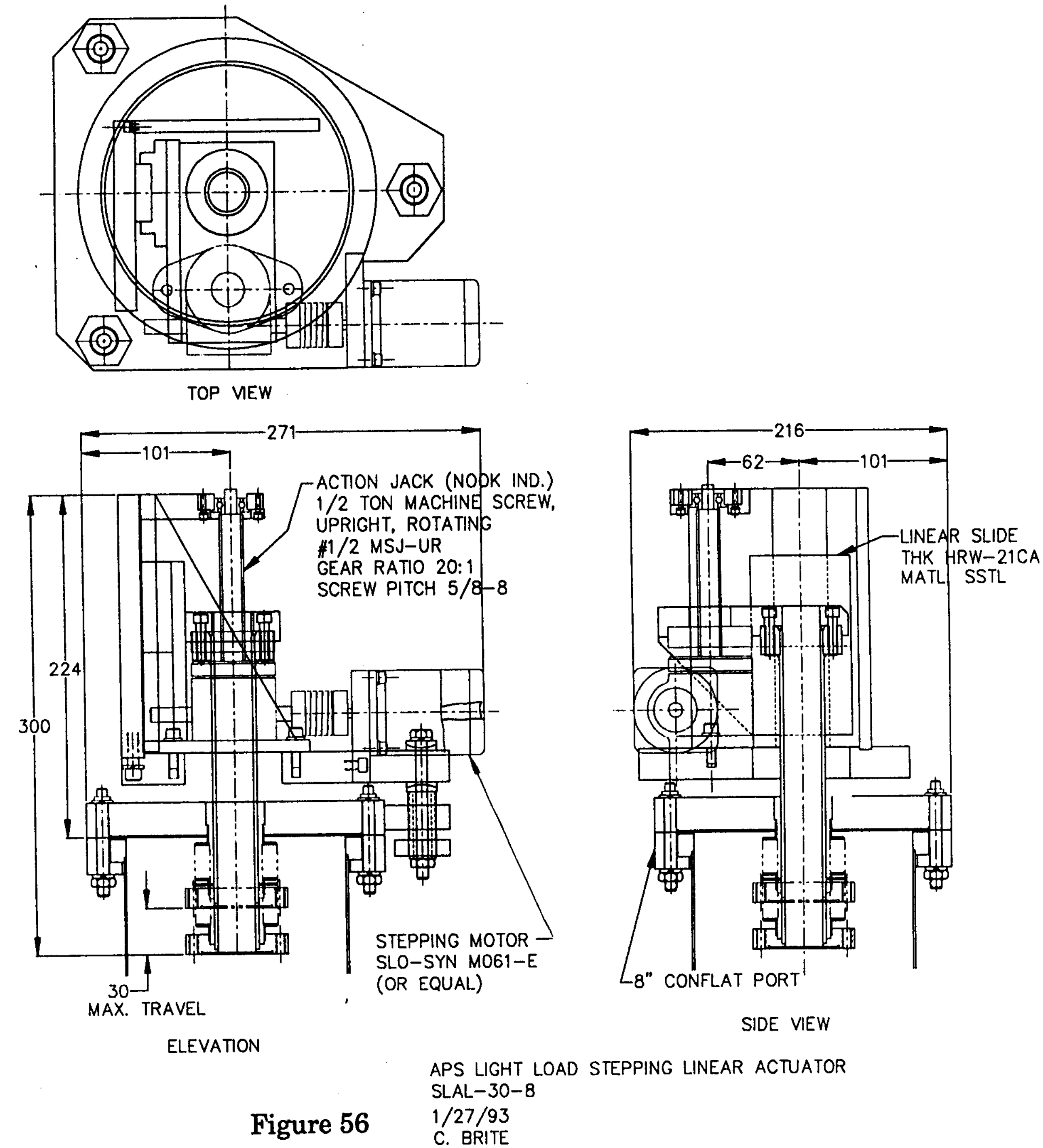

TOP VIEW
271
101
ACTION JACK (NOOK IND.)
1/2 TON MACHINE SCREW,
UPRIGHT, ROTATING
#1/2 MSJ-UR
GEAR RATIO 20:1
SCREW PITCH 5/8-8
224
300
30
MAX. TRAVEL
STEPPING MOTOR
SLO-SYN M061-E
(OR EQUAL)
ELEVATION
216
62
101
LINEAR SLIDE
THK HRW-21CA
MATL SSTL
8" CONFLAT PORT
SIDE VIEW
APS LIGHT LOAD STEPPING LINEAR ACTUATOR
SLAL-30-8
1/27/93
C. BRITE

Figure 56

12.4. APS Light Load Pneumatic Actuator with Pneumatic Drive

A3-81, A3-83

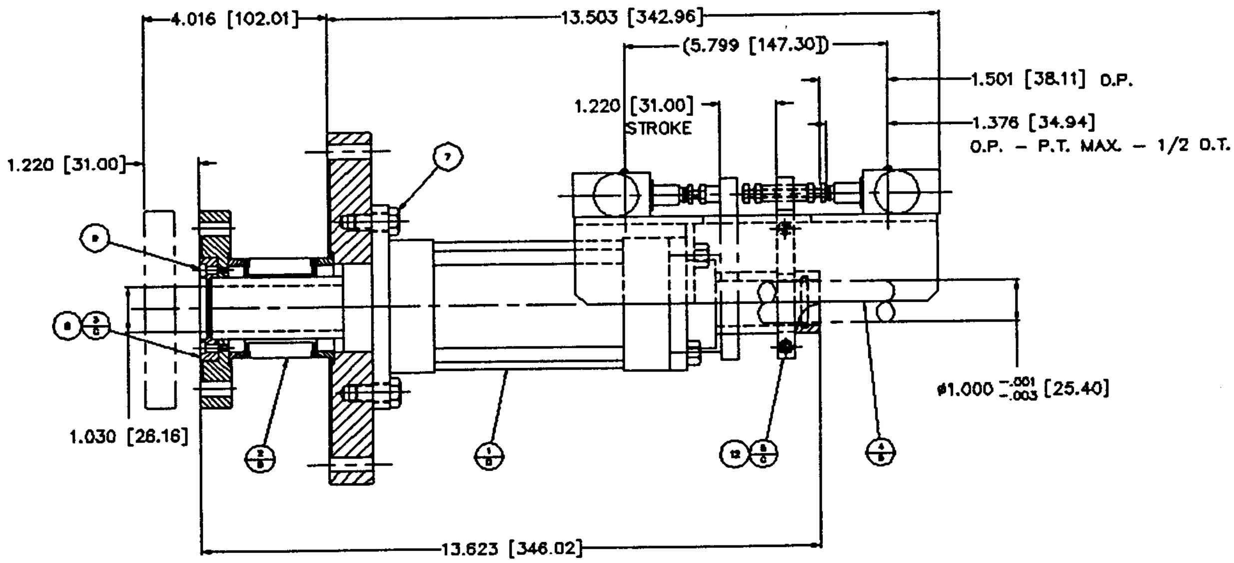
- Light load actuator
- For use with APS monochromatic beam shutters and BM white beam shutters

A typical application for the light load pneumatic actuators is to drive APS monochromatic beam shutters and BM white beam shutters.

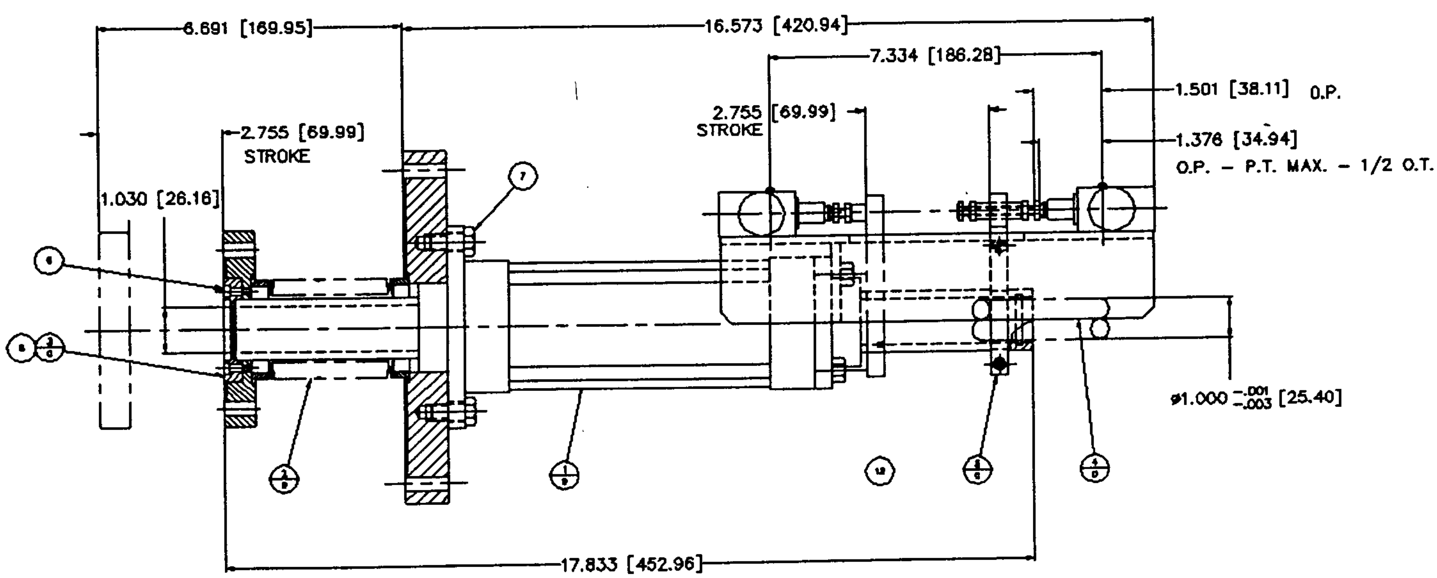
Specifications:

- Stroke:	31 mm ± 0.25 mm & 70 mm ± 0.25 mm
- Motion repeatability:	0.1 mm
- Total axial load	90 kg
- Vacuum load:	17 kg
- Maximum useful axial load:	30 kg
- Actuator flange O. D.:	8 inch
- Feedthrough flange:	4.5 inch
- Maximum feedthrough diameter:	25 mm
- Bore size:	2.5 inch
- Rod size:	1.375 inch
- Bellows O. D.:	56 mm
- Bellows I. D.:	35.6 mm
- Redundant limit switches in each end position:	Micro switch BZZRQ2X-A2
- Pneumatic power supply:	60 - 100 psi
- Maximum closing time:	1 sec
- Pneumatic damping:	in each end position
- Solenoid:	24 V DC (power failure safe design)
- Life time:	500 k cycles
-Vacuum:	UHV compatible

A3–81, 31mm STROKE



A3–83, 70 mm STROKE



APS A3 Light Load Pneumatic Linear Actuators

Figure 57 A3S1.DWG 02–22–1993

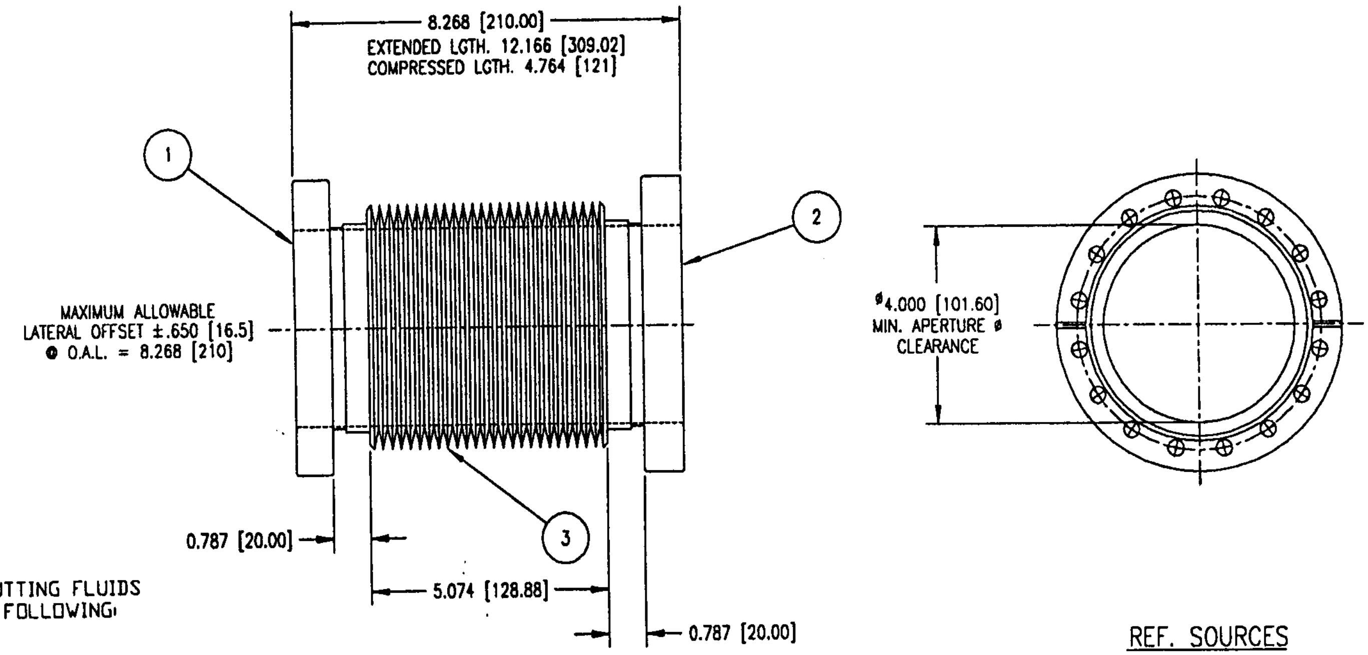
13. Bellows

13.1. Welded bellows

13.2. Formed bellows

Design Status

The design work for welded bellows is complete, while that for formed bellows will be completed before May 1993. With the completion of the designs, these bellows can be procured from vendors. They will also be available from the APS stockroom.



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL

2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL

3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS

   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.

4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.

5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 — STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 — MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

Figure 58

REF	ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
2	3		ST'D. BELLOWS CAT. #497 - 400 - 7 - EE	WITH EXTENDED ENDS	1
1	2	MDC'S CAT. #100026	6" CF. ROTATABLE FLANGE		1
1	1	MDC'C CAT. #110026	6" CF. NONROTATABLE FLANGE		1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127] — ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: A09231
DRAWN BY: MUSCIA — DATE 2/17/93
CHECKED BY:
DESIGNER: MUSCIA
RESPONSIBLE ENGINEER: D. SHU — 2/22/93
MATERIAL: SEE PARTS LIST

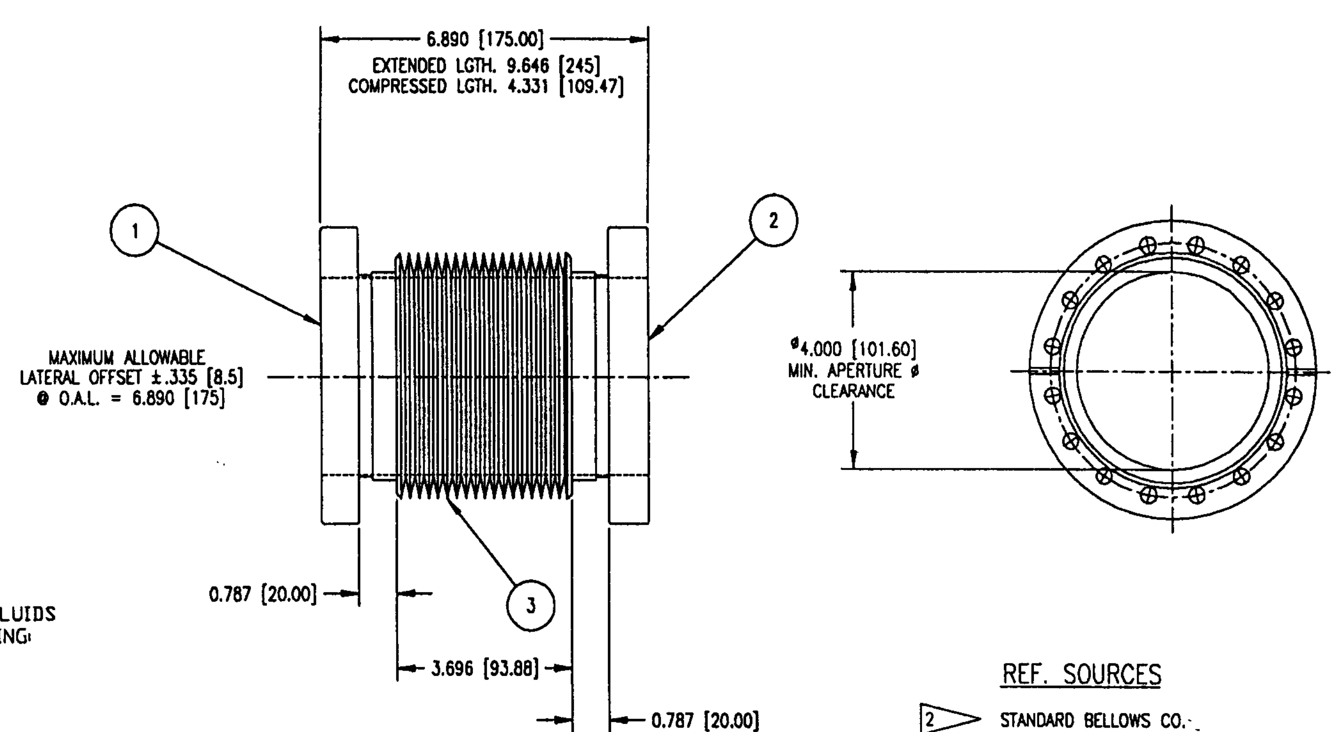
THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY
CHIEF DESIGN ENGINEER: D. SHU — DATE 2/22/93
GP LEADER: T. M. — 2/22/93
PROJECT MGR.
APPROVED/RELEASED

TITLE: ADVANCED PHOTON SOURCE
V2 - 82 WELDED BELLOWS ASSY.
6" - 6" CF. 4" I.D. X 210mm

SCALE HALF — SIZE C — SHEET 1 of 1
DRAWING NUMBER 4105090702-820000-00

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS



REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS

   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

Figure 59

ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
3		ST'D. BELLOWS CAT. #497 - 400 - 5 - EE	WITH EXTENDED ENDS	1
2	MDC'S CAT. #100026	6" CF. ROTATABLE FLANGE		1
1	MDC'C CAT. #110026	6" CF. NONROTATABLE FLANGE		1

PARTS LIST

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127] ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: A09232

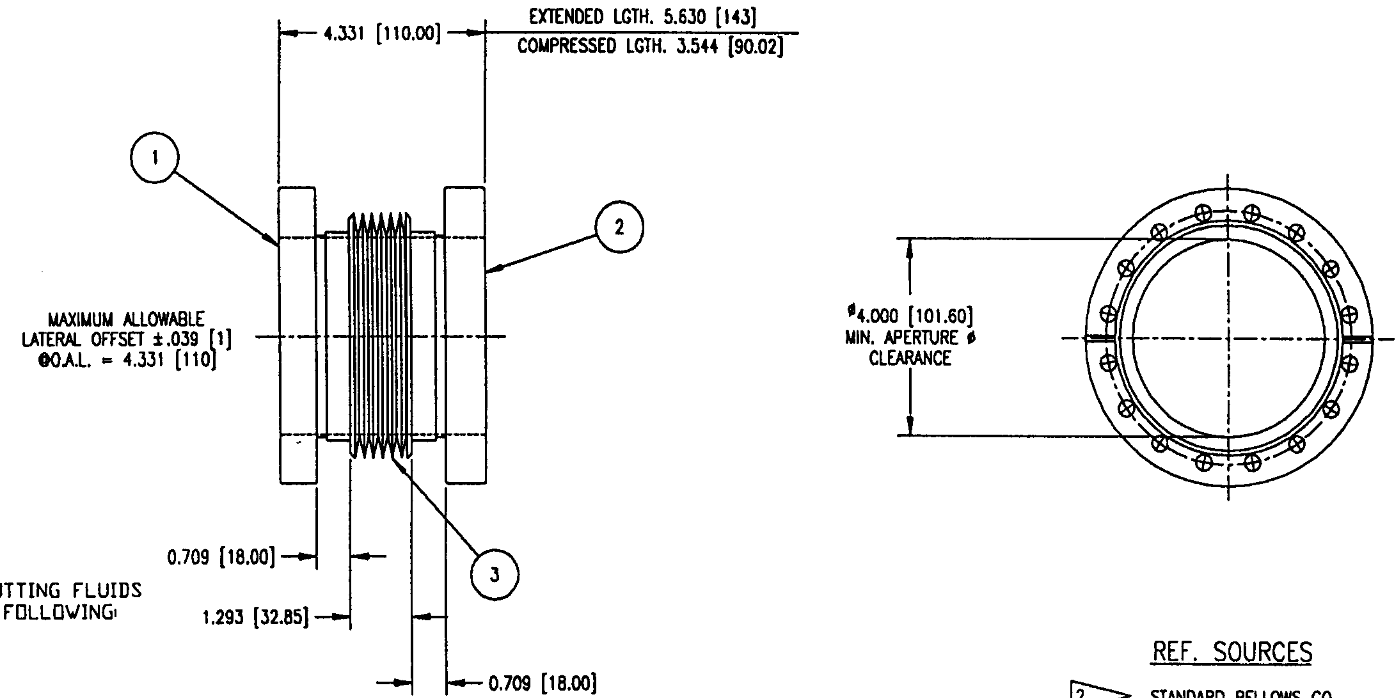
THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

		Date
DRAWN BY	MUSCIA	2/17/93
CHECKED BY		
DESIGNER	MUSCIA	
RESPONSIBLE ENGINEER	D. SHU	2/22/93
CHIEF DESIGN ENGINEER	D. SHU	2/22/93
GP LEADER	T. M. KUZAY	2/22/93
PROJECT MGR.		
APPROVED/RELEASED		

MATERIAL: SEE PARTS LIST

TITLE: ADVANCED PHOTON SOURCE
V2 – 83 WELDED BELLOWS ASSY.
6"– 6" CF. 4" I.D. X 175mm

SCALE: HALF | SIZE: C | SHEET 1 of 1 | DRAWING NUMBER: 4105090702-830000-00



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL

2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL

3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS

   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.

4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.

5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

Figure 60

Ref.	ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
2	3		ST'D. BELLOWS CAT. #497 - 400 - 2 - EE	WITH EXTENDED ENDS	1
1	2	MDC'S CAT. #100026	6" CF. ROTATABLE FLANGE		1
1	1	MDC'C CAT. #110026	6" CF. NONROTATABLE FLANGE		1

PARTS LIST

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127]
ANGULAR: ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: A09233

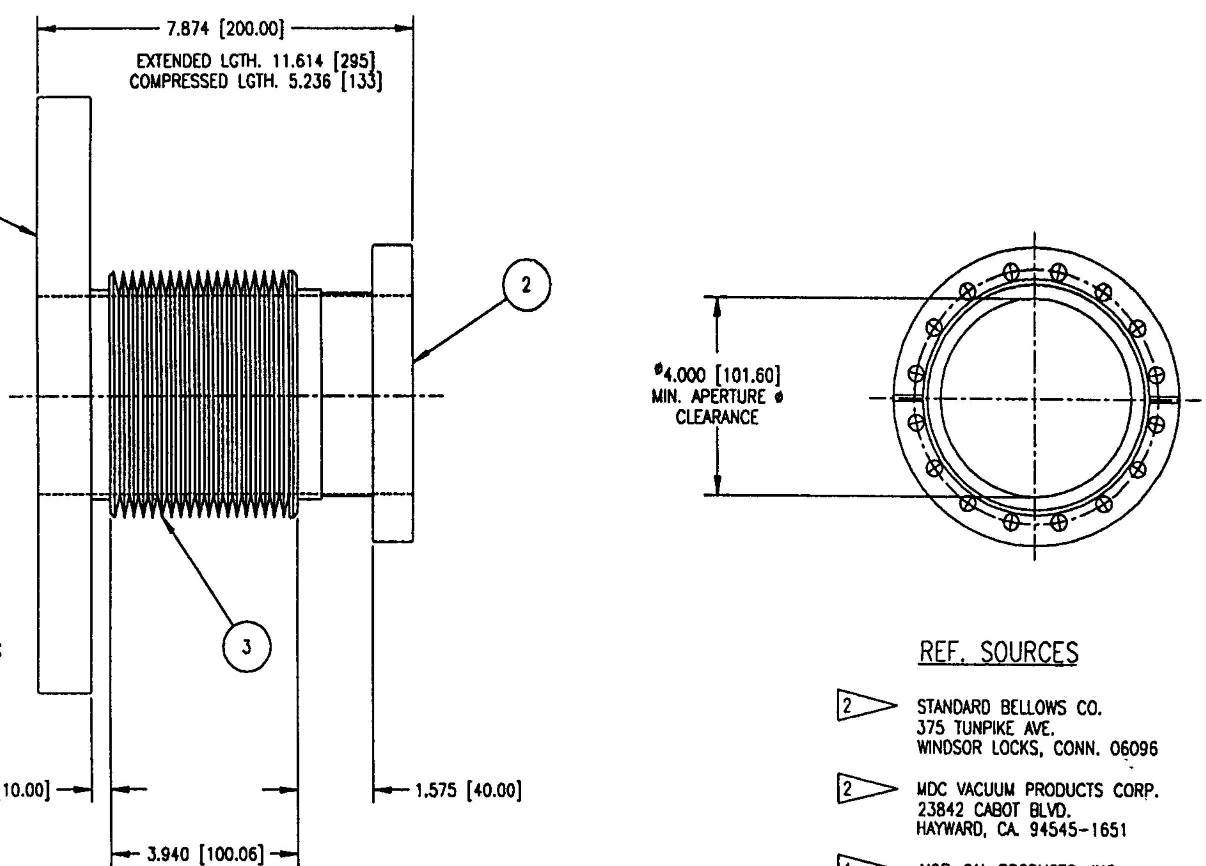
THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

DRAWN BY: MUSCIA	DATE: 2/17/93	CHIEF DESIGN ENGINEER: D. SHU	DATE: 2/22/93
CHECKED BY:		GP LEADER: T. M. KUZAY	2/22/93
DESIGNER: MUSCIA		PROJECT MGR.	
RESPONSIBLE ENGINEER: D. SHU	2/22/93	APPROVED/RELEASED	

MATERIAL: SEE PARTS LIST

TITLE: ADVANCED PHOTON SOURCE
V2 - 84 WELDED BELLOWS ASSY.
6" - 6" CF. X 4" I.D. X 110mm

SCALE: HALF SIZE: C SHEET 1 of 1
DRAWING NUMBER: 4105090702-840000-00



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS

   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

2 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

1 NOR-CAL PRODUCTS, INC.
1967 S. OREGON ST.
P.O. BOX 518
YREKA, CA. 96097

ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
3		ST'D. BELLOWS CAT. #497 - 400 - 6 - EE	WITH EXTENDED ENDS	1
2	MDC'S CAT. #100026	6" CF. ROTATABLE FLANGE		1
1	N.C. #1200-000N	12" CF. NONROTATABLE FLANGE 4" I.D.		1

PARTS LIST

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127] — ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: A09234

THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

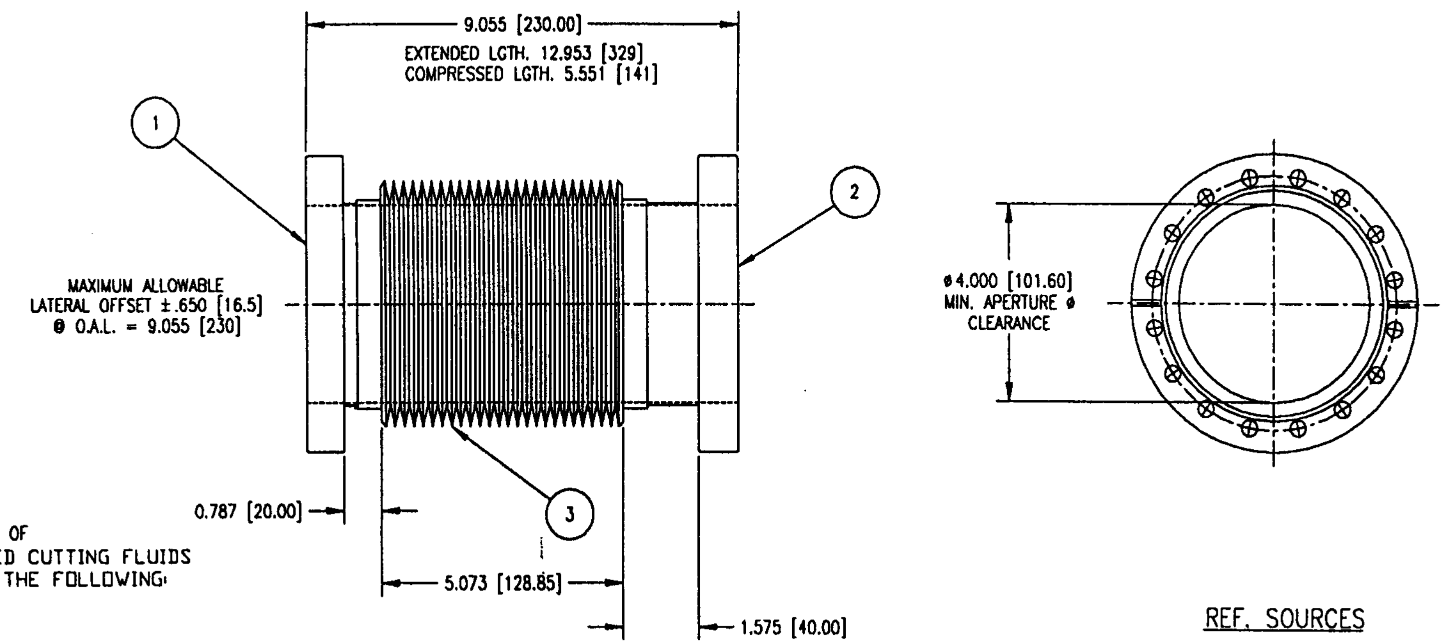
DRAWN BY: MUSCIA	DATE: 2/17/93	CHIEF DESIGN ENGINEER: D. SHU	DATE: 2/22/93
CHECKED BY:		GP LEADER: T. M. KUZAY	2/22/93
DESIGNER: MUSCIA		PROJECT MGR.	
RESPONSIBLE ENGINEER: D. SHU	2/22/93	APPROVED/RELEASED	

MATERIAL: SEE PARTS LIST

TITLE: ADVANCED PHOTON SOURCE
V2 - 85 WELDED BELLOWS ASSY.
12" - 6" CF. 4" I.D. X 200mm

SCALE: HALF — SIZE: C — SHEET 1 of 1 — DRAWING NUMBER: 4105090702-850000-00

Figure 61



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 −10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS

   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

Figure 62

	ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
2	3		ST'D. BELLOWS CAT. #497 - 400 - 7 - EE	WITH EXTENDED ENDS	1
1	2	MDC'S CAT. #100026	6" CF. ROTATABLE FLANGE		1
1	1	MDC'C CAT. #110026	6" CF. NONROTATABLE FLANGE		1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127]
ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER A09235

THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

DRAWN BY: MUSCIA	DATE: 2/17/93	CHIEF DESIGN ENGINEER: D. SHU	DATE: 2/22/93
CHECKED BY:		CP LEADER: T. M. KUZAY	2/22/93
DESIGNER: MUSCIA		PROJECT MGR.	
RESPONSIBLE ENGINEER: D. SHU	2/22/93	APPROVED/RELEASED	

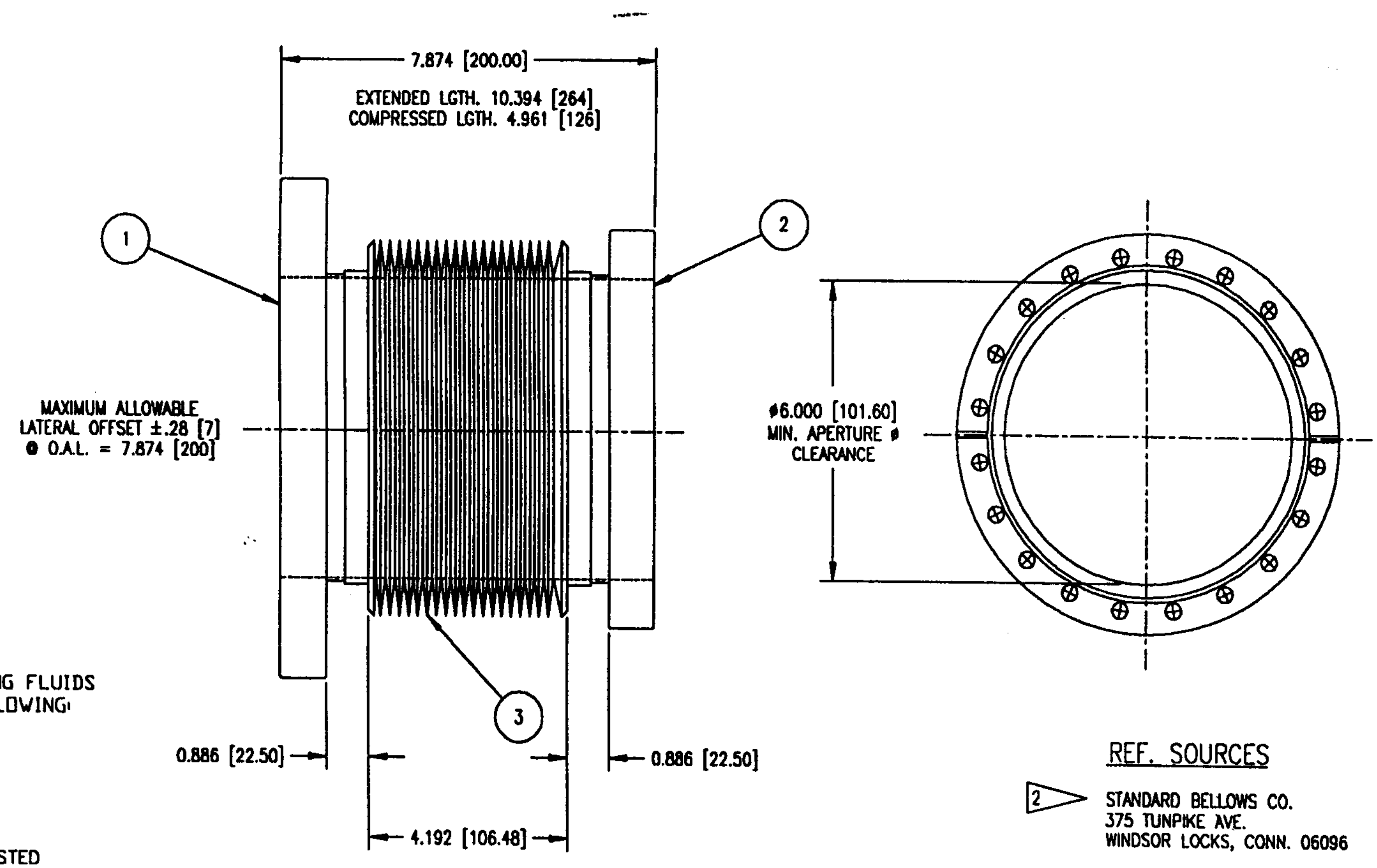
TITLE: ADVANCED PHOTON SOURCE
V2 - 86 WELDED BELLOWS ASSY.
6" - 6" CF. 4" I.D. X 230mm

MATERIAL: SEE PARTS LIST

SCALE: HALF | SIZE: C | DRAWING NUMBER: 4105090702-860000-00 | SHEET 1 of 1

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS
   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

	ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
2	3		ST'D. BELLOWS CAT. #750 - 600 - 5 - EE	WITH EXTENDED ENDS	1
1	2	MDC'S CAT. #100031	8" CF. ROTATABLE FLANGE		1
1	1	MDC'C CAT. #110033	10" CF. NONROTATABLE FLANGE		1

PARTS LIST

Figure 63

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127] — ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: S05258
DRAWN BY: MUSCIA
CHECKED BY:
DESIGNER: MUSCIA
RESPONSIBLE ENGINEER: D. Shu
MATERIAL:

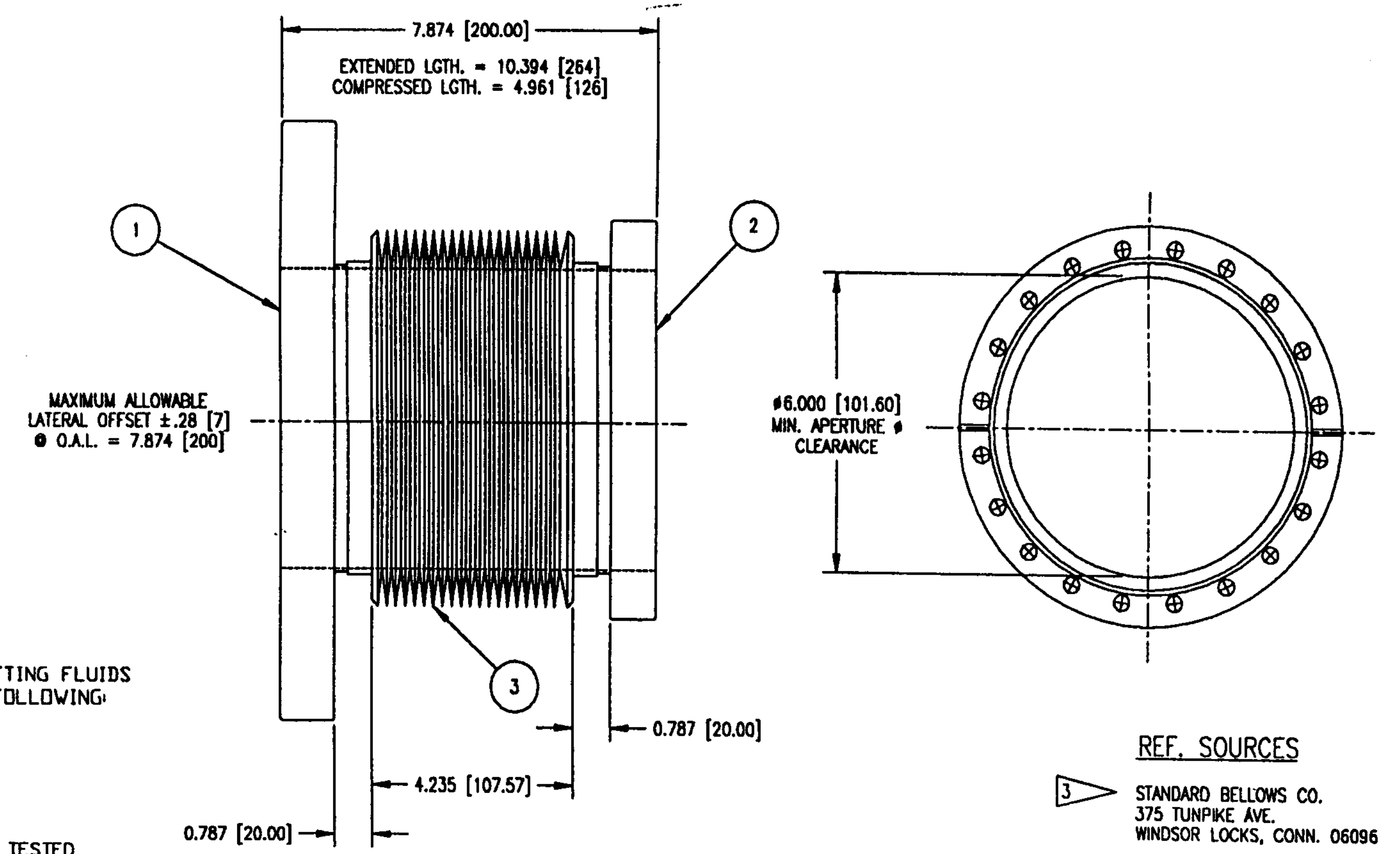
THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY
CHIEF DESIGN ENGINEER: D. Shu
GP LEADER:
PROJECT MGR.
APPROVED/RELEASED

TITLE: ADVANCED PHOTON SOURCE
V2-91 WELDED BELLOWS ASSY.
10" - 8" CF X 6" I.D. X 200mm
(p4105090702-910000-00)

SCALE 1:1 — SIZE C — SHEET 1 of 1 — DRAWING NUMBER

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS
   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

3 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

2 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

1 NOR-CAL PRODUCTS, INC.
1967 S. OREGON ST.
YREKA, CA. 96097

Figure 64

ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
3		ST'D. BELLOWS CAT. #750 - 600 - 5 - EE	WITH EXTENDED ENDS	1
2	MDC'S CAT. #100031	8" CF. ROTATABLE FLANGE		1
1	N.C. #1200-00N	12" CF. NONROTATABLE FLANGE		1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS .X ±.03 [.7630] .XX ±.01 [0.28] .XXX ±.005 [0.127]
ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER S05255
DRAWN BY MUSCIA DATE 2/18/93
CHECKED BY
DESIGNER MUSCIA
RESPONSIBLE ENGINEER D. Shu
MATERIAL SEE PARTS LIST
CHIEF DESIGN ENGINEER D. Shu
GP LEADER
PROJECT MGR.
APPROVED/RELEASED

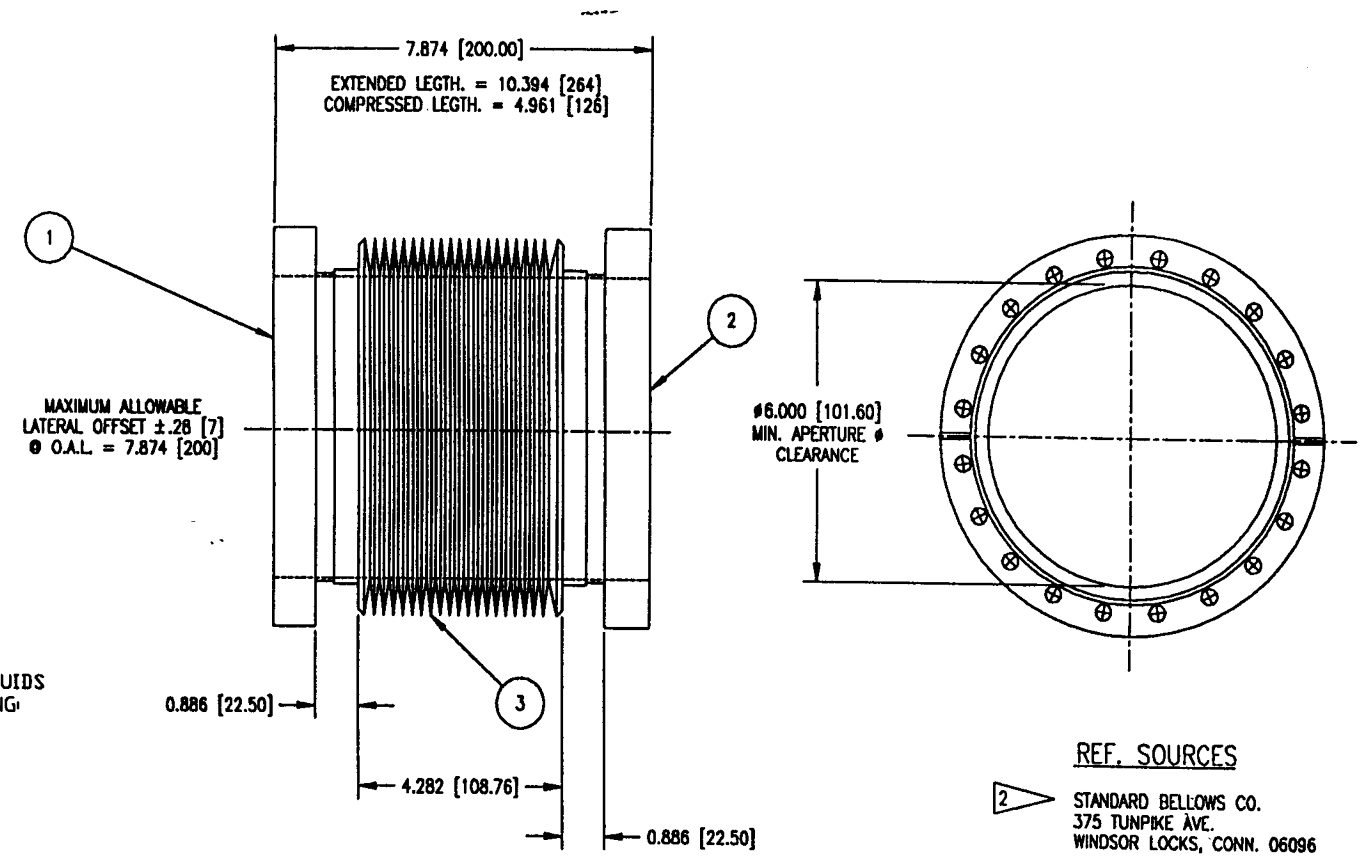
THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

TITLE ADVANCED PHOTON SOURCE
V2-92 WELDED BELLOWS ASSY.
12"-8" CF. 6" I.D. X 200mm
P41-5090702-920000-00)

SCALE HALF SIZE C
SHEET 1 of 1
DRAWING NUMBER

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS
   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

Figure 65

	ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
2	3		ST'D. BELLOWS CAT. #750 - 600 - 5 - EE	WITH EXTENDED ENDS	1
1	2	MDC'S CAT. #100031	8" CF. ROTATABLE FLANGE		1
1	1	MDC'C CAT. #110031	8" CF. NONROTATABLE FLANGE		1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127]
ANGULAR: ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANSI B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST ANSI Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: S05254
DRAWN BY: MUSCIA — DATE: 2/17/93
CHECKED BY:
DESIGNER: MUSCIA
RESPONSIBLE ENGINEER: D. Shu 2/23/93
MATERIAL: SEE PARTS LIST

THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

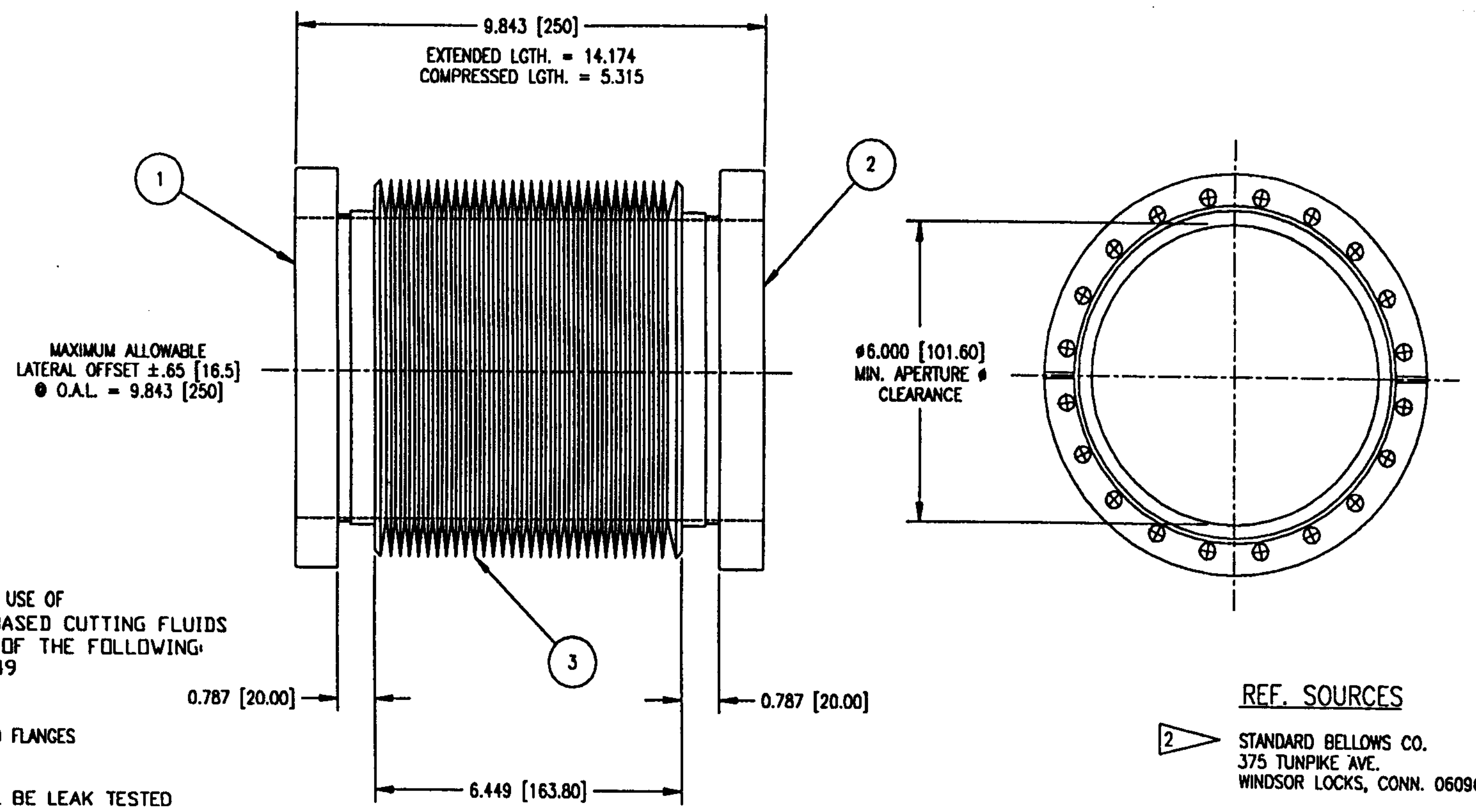
CHIEF DESIGN ENGINEER: D. Shu — DATE: 2/23/93
GP LEADER: 2/23/93
PROJECT MGR.
APPROVED/RELEASED

TITLE: ADVANCED PHOTON SOURCE
V2-93 WELDED BELLOWS ASSY.
8" - 8" CF. 6" I.D. X 200mm
(P4105090702-930000-00)

SCALE: HALF — SIZE: C — SHEET 1 of 1 — DRAWING NUMBER

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL
2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL
3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS
   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.
4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.
5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
3		ST'D. BELLOWS CAT. #750 - 600 - 8 - EE	WITH EXTENDED ENDS	1
2	MDC'S CAT. #100031	8" CF. ROTATABLE FLANGE		1
1	MDC'C CAT. #110031	8" CF. NONROTATABLE FLANGE		1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS .X ±.03 [.7630] .XX ±.01 [0.25] .XXX ±.005 [0.127]; ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST ANS B46.1
DIMENSIONS & TOLERANCES IN ACCORDANCE WITH LATEST ANS Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: S05257
DRAWN BY: MUSCIA — DATE: 2/18/93
CHECKED BY:
DESIGNER: MUSCIA
RESPONSIBLE ENGINEER: D. Shu — 3/3/93
CHIEF DESIGN ENGINEER: D. Shu — DATE: 3/3/93
CP MANAGER: [signature] 3/23/93
PROJECT MGR.
APPROVED/RELEASED
MATERIAL: SEE PARTS LIST

THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

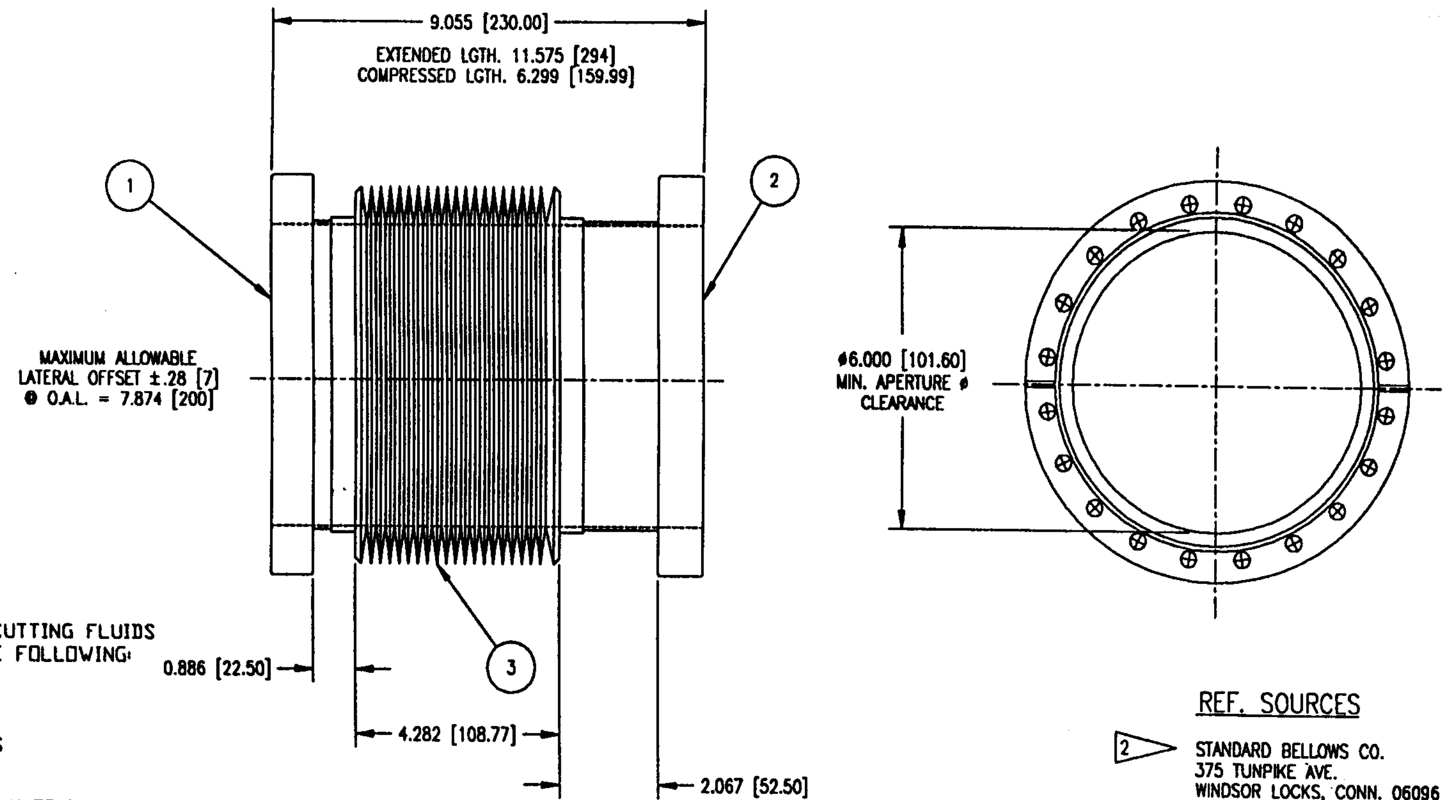
TITLE: ADVANCED PHOTON SOURCE
V2-94 WELDED BELLOWS ASSY
8" - 8" CF. 6" I.D. X 250mm
(P4105090702-940000-00)

SCALE: HALF — SIZE: C — SHEET 1 of 1 — DRAWING NUMBER

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS

Figure 66



NOTES:

1. WHEN MACHINING VACUUM PARTS, USE OF SILICONE AND SULPHUR-BASED CUTTING FLUIDS IS PROHIBITED. USE ONE OF THE FOLLOWING:
   A) CIMCOOL 5 STAR 49
   B) TRIM SOL

2. ALL WELDS JOINING BELLOWS AND FLANGES ARE TO BE INTERNAL

3. BELLOWS ASSEMBLY SHALL BE LEAK TESTED USING A MASS SPECTROMETER WITH MINIMUM SENSITIVITY FOR HELIUM OF 2 X 10 -10 STANDARD CC/SEC PER LEAK METER DIVISION, SUCH AS

   ALCATEL SAM-110TCL
   Du PONT CEC 24-120B
   VARIAN MS-9, MS-90 OR MS-18

   CALIBRATION OF THE LEAK DETECTOR SENSITIVITY SHALL BE PERFORMED JUST PRIOR TO TRESTING.

   FINAL TEST WILL CONSIST OF SURROUNDING THE ASSEMBLY (BAGGING) WITH HELIUM. THE ASSEMBLY WILL BE REJECTED IF A 2% DEFLECTION ON THE MOST SENSITIVE RANGE OF THE LEAK DETECTOR IS SENSED WITHIN 1 MIN.

4. KEEP THE PART CLEAN, AND WRAP FOR UHV PACKING WITH ALUMINUM FOIL.

5. DIMENSIONS IN [ ] ARE MILLIMETERS

REF. SOURCES

2 STANDARD BELLOWS CO.
375 TUNPIKE AVE.
WINDSOR LOCKS, CONN. 06096

1 MDC VACUUM PRODUCTS CORP.
23842 CABOT BLVD.
HAYWARD, CA. 94545-1651

REF.	ITEM	DWG/PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY
2	3		ST'D. BELLOWS CAT. #750 - 600 - 5 - EE	WITH EXTENDED ENDS	1
1	2	MDC'S CAT. #100031	8" CF. ROTATABLE FLANGE		1
1	1	MDC'C CAT. #110031	8" CF. NONROTATABLE FLANGE		1

PARTS LIST

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .X ±.03 [.7620]; .XX ±.01 [0.25]; .XXX ±.005 [0.127]
ANGULAR ±.25°
SURFACE ROUGHNESS 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .03 MAX.
SURFACE TEXTURE TO BE IN ACCORDANCE WITH LATEST AND B46.1
DIMENSIONING & TOLERANCING IN ACCORDANCE WITH LATEST AND Y14.5
DO NOT SCALE DRAWING

LOG NUMBER: S05256

DRAWN BY: MUSCIA — DATE: 2/18/93
CHECKED BY:
DESIGNER: MUSCIA
RESPONSIBLE ENGINEER: D. Shu
MATERIAL: SEE PARTS LIST

CHIEF DESIGN ENGINEER: D. Shu
CP LEADER: 2/23/93
PROJECT MGR.
APPROVED/RELEASED

THIS DRAWING IS THE PROPERTY OF ARGONNE NATIONAL LABORATORY

TITLE: ADVANCED PHOTON SOURCE
V2-95 WELDED BELLOWS ASSY.
8" - 8" CF. 6" I.D. X 230mm
(P4105090702-950000-00)

SCALE: HALF — SIZE: C — SHEET 1 of 1
DRAWING NUMBER

SYM	CHANGE DESCRIPTION	BY	CHKD	DATE

REVISIONS

Figure 67